

Building bridges, breaking barriers

The smart approach to distance between disciplines in research projects



FINAL REPORT

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Acronyms

DAE	Digital Agenda for Europe
H2020	Horizon 2020
MD	Multiple Disciplinary / Multiple Disciplinarity
MDA	Multiple Disciplinary Approach
SSH	Social Sciences and Humanities

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Abstract

This study, requested by the European Commission, addresses the challenge of multiple disciplinary interactions in Horizon 2020 projects, specifically in those with relevance to the Digital Agenda for Europe. It makes a series of recommendations that are aimed at improving the relevance, effectiveness, and appropriateness of multiple disciplinary interactions. The study is addressed to the European Commission, national research councils and other scientific funding agencies, the research community, and Horizon 2020 proposal evaluators and project reviewers. We show where interactions between disciplines add value to research and innovation projects. In doing so, we create a 'smart approach' to implementing multiple disciplinary interactions. Through this study, we invite the variety of actors involved in all elements of the Horizon 2020 research process to critically reflect on their own aspirations for the future of multiple disciplinary interactions in research.

Avant-propos

Ce rapport, commandé par la Commission européenne, concerne le défi des interactions entre différentes disciplines dans le cadre des projets de «Horizon 2020», en particulier ceux liés à la «stratégie numérique pour l'Europe». Le rapport explique nos propositions pour améliorer la pertinence et l'efficacité de la «multiple disciplinarity» (multidisciplinarité, interdisciplinarité, transdisciplinarité, ...). Le rapport cible différents interlocuteurs: la Commission européenne, les fondations de recherche nationales et des autres organisations qui subsidient la recherche, les chercheurs, et les évaluateurs des propositions et des projets de «Horizon 2020». Le rapport souligne quand les interactions entre disciplines sont les plus efficaces. On crée une approche «smart» avec recommandations pour maximiser des gains potentiels des interactions. Avec ce rapport, nous invitons les acteurs concernés par «Horizon 2020» à réfléchir à leurs aspirations pour le futur des interactions entre les disciplines dans les projets de recherche.

Executive summary

This study outlines a ‘smart approach’ to multiple disciplinarity in the Digital Agenda for Europe-relevant sections of Horizon 2020.

During our investigations, we found many enthused, critical and curious voices. We interacted with cynics and supporters alike. We spoke to hopeless optimists and weary pessimists, and learnt a lot about journeys that individuals have taken towards interacting with disciplines. Many individuals felt that the problems they faced were structural; others felt that the challenges were driven by individual human nature. We contend that these problems cannot be solved with one silver bullet. Nor does responsibility for finding the ‘solution’ solely lie with one particular actor. Our ‘smart approach’ should be read in this light.

We propose a set of recommendations that will help address how, when and under what circumstances multiple disciplinary interactions could take place to ensure that benefits are maximized and inefficiencies are reduced to a minimum. Our recommendations relate to six major areas: (I) shaping the dynamics of the relationships between different disciplines, (II) encouraging positive attitudes and aspirations of individual researchers and research teams, (III) structuring projects in order to enhance the role of different disciplines, (IV) structuring call texts and using additional tools and mechanisms to ensure that useful interaction across disciplines is guaranteed, (V) evaluating and reviewing proposals and projects, and (VI) communicating multiple disciplinary approaches to the research community. Our target audiences are the European Commission, national research councils and other scientific funding agencies, the research community, proposal evaluators and project reviewers.

Engagement dynamics

Many aspects of multiple disciplinary approaches concern human interaction. In this study, we identify several ways in which Horizon 2020 can shape the engagement dynamics among different disciplines:

- Allocate a floating budget to allow for uncontrolled interactions
- Organise mono-disciplinary ‘sister projects’
- Learn from project partners in dedicated concertation meetings, or ‘unconferences’

Attitudes and aspirations

Integrating disciplines leads to greater (societal and policy) relevance for technological research, and therefore more chances to achieve key societal goals. We believe there is a need to create space for cultural change:

- Establish positive attitudes towards multiple disciplinarity
- Incentivise and reward multiple disciplinarity in the research environment: multiple disciplinary research groups, degrees, events, publications
- Ensure continuity of multiple disciplinary approaches

Project design and structure

Multiple disciplinarity entails adequate resources: time, money and wo/manpower. A ‘smart approach’ to multiple disciplinarity considers project designs and structures:

- Encourage multiple disciplinary engagement: opening exercises, regular meetings, research stays
- Appoint a multiple disciplinary project coordinator
- Identify added value of multiple disciplinarity in your project
- Provide evidence of coordination between disciplines

Call text formulation

Further, it is necessary to reflect on how to call for multiple disciplinary approaches. We feel that innovative ways of approaching multiple disciplinarity should be encouraged:

- Enhance the participation of social sciences and humanities in the drafting of call texts
- Award prizes for multiple disciplinary solutions to societal challenges
- Encourage project budget allocation for multiple disciplinarity in call texts

Evaluations and reviews

Moreover, we propose that a smart approach would require proposers to explicitly state how the consortium intends to work together in an interdisciplinary fashion should they choose to do so. In addition, multiple disciplinarity should be subject to specific evaluation and review:

- Enact public reviews and encouragement for reflexive self-reviews (separate from Administrative Review)
- Organise process for proposal evaluations that are executed by representatives from different disciplines
- Create multiple disciplinary 'sounding boards' beyond individual projects
- Carry out multiple disciplinary-specific evaluation in project proposals

Communicating MDAs to the research community

Last but not least, it is important to communicate multiple disciplinary approaches to the research community:

- Share best practices amongst peers
- Review multiple disciplinary approaches in the (interim) review of the Horizon 2020 programme
- Use the proposers' days to communicate elements of the 'smart approach'

Chapters 1 through 3 of this study provide the details of the 'smart approach'. For the purposes of this report, several different evidence-gathering activities took place:

1. An online survey, sent out to over 100 FP7 project coordinators
2. Case analyses of a small selection of FP7 projects
3. An in-depth literature review
4. Interviews with a limited number of multiple disciplinary researchers
5. Focus group exercises at ICT2013, Vilnius
6. A brainstorming workshop, held in Brussels in April 2014
7. A validation workshop, held in Brussels in September 2014

Combined, these activities have helped to construct the final report. They are reported on in the annex to this study.

1 The promise and perils of multiple disciplinarity

Multiple disciplinarity (MD) has been a clarion call for researchers in recent decades. Almost unquestioningly, this term has been used to promote interactions in research, specifically in relation to 'real-world problems' and 'policy-relevant research'. However, our findings show mixed opinions concerning the role of multiple disciplinarity in the research environment.

Through our literature review and survey analysis, we identify an intrinsic value in sharing insights between different disciplines. At a general level, our survey respondents explain that **multiple disciplines add value in situations where there is a need to make a better link between theory and practice, provide different perspectives on a problem, generate comprehensive research approaches, generate policy-relevant insights and foster creativity and out-of-the-box thinking**. At a project level, our workshop participants indicate that it can be difficult to pinpoint in advance how multiple disciplinarity will add value. For this reason it is important to leave sufficient room for planned and unplanned interaction between disciplines.

For specific technological solutions to policy (societal) issues where agreement on desired outcomes is apparent, we dare to assert that **Multiple Disciplinary Approaches (MDAs) do not add much value to smaller projects. Similarly, the added value in larger projects is harder to achieve when project outcomes are stated at the proposal stage**. This runs counter to so-called common wisdom, but is drawn from our case analyses and survey data, with responses from a number of EU-funded projects. Our reasoning for this stems from our insight into the nature of EU-funded projects, which are limited in time, and thus require project researchers to be engaged in their own disciplinary fields in order to maintain job security after the end of a project. However, even under this heavy limitation, MD can add value in the **proposal writing and design stages of a project, and in the prototyping, testing and validation of products**.

MDAs allow for critical responses to dominant (and often overpowering) responses to complex societal challenges. They give the research community an opportunity to provide alternative paths towards addressing these problems, and are particularly useful where contestation is rife. Issues where there is no 'right answer', such as the Internet of Things (privacy), Robotics and cyber-physical systems (ethics), Big Data (data protection), and Security (surveillance), must be approached with due attention for the societal issues at stake. Although they are stated here between parentheses, these contested issues are central to the success of these technology topics.

Our interviewees state that multiple disciplinarity exposes researchers to their own terminologies, it encourages learning through difference and breaking or affirming paradigms. Multiple disciplinarity challenges researchers to refine their understandings, and forces them to clarify them. It pushes researchers to see that established truths within their disciplines are not the 'only' truth. It encourages out-of-the-box thinking, it enriches our own writing and contributes to the expansion of each other's viewpoints. Thus we see, on the one hand, the pure 'academic' value of adding new insights into established research programmes, and on the other hand, we see the improvements in our tools and methods for breaking down frontiers to solve societal problems.

Furthermore, concerning technological tools and artefacts, we see the value of integrating and articulating multiple disciplinary insights into research and development activities. Respondents to our survey, various interviewees, and interactions with other individuals in our group activities (workshops and focus groups) all state the benefits of considering the entire technology adoption cycle when designing and developing specific tools. Approaching research from multiple disciplines increases potentials for societal acceptance/adoption of technological development, and can contribute to more profound and new understandings of societal and research problems. As our literature review shows, interactions between disciplines can produce insights that would never have been conceivable to researchers entrenched in their own ivory towers.

Researchers appear to engage in multiple disciplinary projects for specific reasons. Indeed many feel that the toolbox that their own discipline provides them does not address the challenges of the 21st century. This makes them uncomfortable with their own position in a specific research field, dominated by people who work solely with the aim of fuelling the discipline, rather than addressing broader questions raised. In essence they are often seeking answers to questions that lie beyond the confines of their own discipline.

Our literature review shows the different ways in which the scientific community see interactions between disciplines. Many different prefixes have been added to the word 'disciplinarity' to try to capture different interactions between disciplines. These terms are sometimes used interchangeably, but relate to the different dynamics between disciplines. This relates to the type of multiple disciplinary approach (MDA) applied in a project. Several projects aspire (or discover the need) to create new disciplines during the progression of their work (think neuro-chemistry, computational biology, internet science). Others wish to transcend disciplines in order to answer more holistic questions that cannot, by definition, be answered by one discipline. Our literature review expands on how these different activities have evolved in the academy.

This perception of **the added value and positive nature of working across disciplines should not result in blanket, unequivocal calls for different disciplines to interact together at all moments in collaborative research exercises**, however. Such normative embracing of multiple disciplinarity results in the problem of multiple disciplinarity for multiple disciplinarity's sake. Multiple disciplinarity is sometimes carried out 'because call texts asked for it'. This artificial forcing together of researchers can sometimes have pleasant (un)intended consequences, but often turns into a box-ticking exercise designed to simply please (or appease) project reviewers. In order for it to be successful, effort and time must be allocated to the exercise. Disciplines still have value, and a dogmatic belief in the necessity of mixing disciplines together only serves to frustrate researchers, and produce 'undisciplined' research results.

Indeed, our analysis of research outputs and interviews with specific individuals involved in various projects reveals that in many cases, so-called multiple disciplinary activities are basically strands of monodisciplinary activities that are layered on top of each other. Superficially, a glaze of different disciplinary input marks certain so-called multiple disciplinary activities in many projects. This approach to multiple disciplinary activities weakens the real value of integrating or engaging with multiple disciplines. This 'forced' or 'superficial' integration of disciplines is detrimental to all stakeholders. Sometimes multiple disciplinary approaches are best taken 'outside' of specific projects; forced integration is not the most useful or creative approach to deal with a problem. This rather predictable state of affairs emerges when call texts present

proposers with a list of expected impacts/solutions that have often been written with mono-disciplinary approaches in mind.

Moreover, the concerns surrounding multiple disciplinarity do not stop with the 'means', but continue to the 'ends'. As we have noted during our various interactions with individuals during the course of this study, **researchers tend to strongly support the 'idea' of interactions between disciplines, but when interrogated about the actual concrete benefits of such activity, answers are less positive and are often far more critical of the hierarchies that emerge in the technology-driven projects in which they participate.**

In fact, interaction between disciplines is perceived as a costly exercise for all concerned, and in some cases leads to frustration, misunderstanding and lowest common denominator results. In many instances during project execution, certain participants feel that multiple disciplinarity simply adds additional baggage to a project. This is not due to ignorance, unwillingness, or indifference on the part of different disciplines to the benefits of MDAs. It is, in large part, due to the constraints placed on those researchers by their training and career needs, which have taught them to deal with different disciplines in hermetic ways. In addition, many social scientists involved in these projects are working to specific and concrete objectives (predetermined in a proposal written months, if not years ago), are often pressed for time and need to deliver project deliverables that might not give them a chance to explore in-depth the social science/humanities 'value' of their work. When specific goals have been agreed upon with a project funder, it is often a hindrance for individual partners to have to interact with members of their consortium who may make them reconsider their own language use and explain terms that are implicitly understood by people from their own discipline.

In addition, although policy-relevant research projects may be a way for researchers to find multiple disciplinary homes, these projects are limited in time. Academic researchers find it remarkably difficult to rely upon such funding streams whilst developing curriculum vitae that allow them to maintain their status at their home universities. Research careers are still often built on reputation as gathered within the confines of a specific discipline, as opposed to across different disciplines. Promotions are granted by superiors who recognize excellence in disciplinary terms and are unable to evaluate research excellence outside of those boundaries. Thus, **crossing borders is often difficult for researchers who are wedded to a specific career path and recognize that the means to achieving their career goals are firmly within their own discipline.**

Our research results suggest that much depends upon the researcher in question. **'Bridge scientists' (or boundary persons) are able to bridge disciplines and maintain successful (academic) careers, and yet these individuals are few and far between.** One of our interviewees refers to himself as 'being comfortable in the crack between disciplines' but aware that for most researchers, this is considered 'career suicide'. Whilst the concept of the bridge scientist sounds appealing, and is particularly interesting for very young or highly experienced researchers, the 'bridging' exercise is particularly challenging for mid-career researchers to execute, given the demands placed on them by their home disciplines (or by the two disciplines they are bridging). Furthermore, 'bridging' disciplines does not necessarily imply that a scientist is able to successfully 'marry' two disciplines, but only to make a link between them. This type of interdisciplinary activity is only one of the ways in which different disciplines can interact. Our literature review provides further details.

Finally in this study, we focused on the topic of privacy and technology. The importance of the notions of 'privacy' and 'data protection' is of at least twofold in nature. First, from the legal viewpoint, it is a fundamental right protected by international and supranational legal arrangements, in particular Arts 7-8 of the EU Charter of Fundamental Rights and Art 8 of the European Convention on Human Rights, as well as virtually all national constitutional systems in western democracies. Second, the place of privacy and data protection in contemporary, digital society is unprecedented. Privacy is a ubiquitous and non-separable element of digital societal developments. As we deal with DAE, the research projects will always concern technological developments in one way or another. It is well known that technology can have a negative impact on the protection of individual's privacy and personal data (Brownsword & Goodwin, 2012). Any interference with privacy and data protection that is not permitted by these legal instruments would constitute an infringement, and compliance with privacy and data protection must be ensured.

Many researchers engaged with privacy issues tend to have highly divergent perspectives concerning the importance of privacy in their work. This is, in part, due to the 'fuzzy' nature of the concept: **for many researchers privacy is something that needs to be resolved by lawyers and (other) social scientists once the tools has been developed;** for others privacy is something that they 'choose' not to deal with, in order to enable them to develop an effective and efficient technological solution to a specific problem identified in a research call. In our discussions with coordinators of projects where privacy was a key element, we discovered that privacy was always considered 'in principle' as a key determining factor, but 'in practice' as a burden to the swift delivery of project results. Privacy, as a 'soft' and 'intangible' element is regarded as a second-class citizen in technology-driven research projects. Coordinators rely on its presence, but are not always willing to run the project according to its wishes.

Through this broad lens of privacy, we are thus able to see how different aspects of the topic necessitate treatment by different disciplines. Our findings indicate that in research **in the domain of privacy challenged by emerging technologies, a multiple disciplinary approach is almost certainly a necessity.** For instance, a research project on surveillance, if examined against privacy principles only, will not give a complete picture of the societal impact. Insights from applied ethics, security studies and surveillance studies, among others, are crucial. What is not clear is the way in which the interactions between disciplines, as fundamental building blocks of research activity, should be articulated.

2 The role of social sciences and humanities

In the story of multiple disciplinary interactions, the role of social sciences and humanities is key and necessary for contextualising, understanding, strengthening and learning, which can in turn ensure that project risks are appropriately minimized and potentials for take-up may be far greater. We recognise the need for multiple disciplinary approaches that are more than just a tool to integrate social sciences and humanities into the mainstream of technology-driven research projects. Integrating disciplines leads to greater (societal and policy) relevance for technological research, and therefore more chances to achieve key societal goals.

As currently set up, one of the major criticisms of multiple disciplinarity in EU-funded projects is the so-called ‘WP1 syndrome.’ Social scientists are asked to write a big report which everyone approves and subsequently ignores. Another way in which multiple disciplinarity emerges in the current research setup, is in field trials. Here, social scientists are only involved after the technology is developed. This is too late to have a concrete impact on design.

It is clear that **social sciences and humanities (SSH) have been the underdog in DAE-relevant projects until now.** Social scientists regret the minority role. One interviewee states, “we want to have an impact on the lower layers of the technology, on its features, on the ways in which user practices are encoded. This can only occur if social sciences are involved throughout the whole process.”

SSH needs to be better integrated into the programme structure, perhaps in parallel, or supporting roles in individual projects. There should also be space for SSH-driven projects that run completely independently from technology-solution-delivery projects, that provide a space for reflection on the relationship between technology, policy and society. We suggest ways below. In particular, we have identified stages at which multiple disciplinary approaches are most useful in research endeavours: proposal writing, design, prototyping, testing and validation. We also wish to state that we see broad opportunities for SSH researchers to be concretely engaged in more exploratory, discovery-driven research that does not have a pre-determined social impact generated either at the inception of the project, or by the funding requirements.

In this regard, we need to address the reality of how the different disciplines work. **Social sciences work ‘slower’ than other disciplines, and yet their input is a pre-requisite for a well-considered technical solution.** This is challenging. Currently user researchers feel underutilized, unable to influence, while technology researchers find user research helpful, but consider that it delays the process. Social scientists feel that they are often ‘called in’ to ‘justify’ the work of the technologists – to legitimise predetermined solutions as opposed to helping create them.¹ Due to the reflection that takes place within this broad family of disciplines, SSH also provides the conceptual space to allow for exploration and discovery to take place, which can be crucial in specific types of more curiosity-driven projects.

¹ We recognise the call for ‘open’ and ‘co-creative’ mechanisms in science that this statement implies. We invite the reader to refer to the Collective Awareness Platforms for sustainability and social innovation, the discourse on open learning, open collaboration and open innovation, as well as our specific recommendations on ‘sister projects,’ public reviews, and unconferences.

Underlying are differences in how we approach research. Indeed **computer scientists and engineers tend to have a positivist worldview – they acquire knowledge through capturing, measuring and modelling.** Frequently this corresponds with quantitative research methods. Most **social scientists however, adopt an interpretivist worldview – they gain understanding through inquiring into human experience.** Then qualitative research methods are the norm. Often there is a lack of understanding and appreciation for each other's approach. In our view projects should take time to start up conversations on worldviews and methods, to explain, share, benefit and return to their original disciplines.

3 Shaping a smart approach to multiple disciplinarity

This section presents our proposal for a ‘smart’ approach to maximize the benefits to be gained from multiple disciplinary endeavours. We address six major areas.

The first three relate to the way in which projects are conceived, managed and run:

- Shaping the dynamics of the relationships between different disciplines (or “how to manage projects in practice”),
- Encouraging positive attitudes and aspirations of individual researchers and research teams (or “discovering space for cultural change”)
- Structuring the projects in order to enhance the role of different disciplines (“how to do research and maximize value”).

The following three concern the way in which multiple disciplinarity is presented in research calls, communication and review:

- Structuring the call texts and using additional tools and mechanisms to ensure that useful interaction across disciplines is guaranteed (“how to call for MDAs”),
- Evaluating and reviewing of proposals and projects (“how to evaluate proposals”), and
- Recommendations on how multiple disciplinary approaches in the context of DAE-relevant elements of H2020 should be communicated to the research community at large (“how to write proposals”).

The table below highlights the key recommendations for our smart approach. At the end of this section, we highlight which of these elements of the smart approach are directed at specific groups of actors.

Elements of the smart approach	
	Engagement dynamics (I)
	Uncontrolled interactions – floating budget (I.i)
	Sister projects (I.ii)
	Concertation meetings – ‘unconferences’ (I.iii)
	Attitudes and aspirations (II)
	Positive attitude towards MD (II.i)
	MD research environment (II.ii)
	Continuity of MDAs (II.iii)
	Project design and structures (III)
	Encourage MD engagement – initial exercises, research stays and regular meetings (III.i)
	MD project coordinator (III.ii)
	Clear identification of where MD adds value within projects (III.iii)
	Evidence of coordination efforts between different disciplines (III.iv)
	Call text formulation (IV)
	Enhance SSH participation in drafting of call texts (IV.i)
	Prizes for MD solutions to societal challenges (IV.ii)

Additional project budget for MD projects (IV.iii)
Proposal evaluations and project reviews (V)
Public reviews and encouragement for reflexive self-reviews (separate from Administrative Review) (V.i)
Proposal evaluations executed by representatives from different disciplines (V.ii)
MD 'sounding boards' ('the lighthouse') (V.iii)
MD-specific evaluation in project proposals (V.iv)
Communicating MDAs to the research community (VI)
Sharing best practices (VI.i)
MDA review in (interim) H2020 review (VI.ii)
Proposers' days (VI.iii)

Table 1 Elements of the smart approach

3.1 Dynamics of engagement between different disciplines

A lot of benefits that can be gained from MDAs are about the human element. The opportunities for chance encounters, fortuitous serendipity and prolonged and deep social contacts cannot be underestimated, although it is rather difficult to place these elements of MD within the context of a targeted research project. To this end, we see many of these dynamics as needing to spring from the researchers themselves. However, there are several things that H2020 can indeed try to stimulate in different ways.

Engagement between disciplines need not always require specific methods, modes, or tools for MDAs. As noted in the literature review, disciplines have always interacted with each other, without the need for new labels. The sheer fact of *having conversations between different disciplines is worthwhile*. The idea of uncontrolled interactions is a very promising one, and we propose that each project receive a **'floating budget'** (for example, the equivalent of each researcher's 'Friday afternoon') which can be assigned to 'exploratory initiatives' relating to the project's activities (I.i). This would allow researchers to allocate time to explore avenues that do not need to be 'evaluated' against project objectives, and may reduce the 'box-ticking' approach that sometimes plagues multidisciplinary interactions. Discovery often emerges from research carried out in non-predetermined settings, and researchers need time to capitalise on this in the context of their project. Such a floating budget, not attributed to specific work packages, could be an element of the final reporting procedure in project reviews.

Different disciplines can act as a 'sense check' against which to test assumptions and predispositions that emerge during work, and particularly in the beginning when project interactions start. Indeed, this work should take place in the very early (proposal writing) phase of any project. It may be wise to assume that this has strong consequences for the fundamental structure of specific projects. We can envisage projects that are designed as a series of bouncing conversations between disciplines, as appears to be the case in projects where privacy is an issue, notably between lawyers and technologists.

As identified in the literature review, many projects do not need to be 'multidisciplinary' *per se*. It is highly dependent upon the nature of the project. We acknowledge that space within H2020 for mono-disciplinary research projects should

be maintained, and that call texts should be open to proposals for well-defined MDAs in projects. Sometimes multiple disciplinary approaches are best taken outside of specific projects; forced integration is not the most useful or creative approach to deal with a problem.

Given the different speeds of development, and the reliance upon different scientific paradigms (positivist/quantitative vs. interpretivist/qualitative), we also propose that dynamics between disciplines might be served well by operating '**sister projects**' (I.ii). These projects would run in parallel with others in the same call area, and explore the same topics of research from different disciplinary perspectives in order to provide a sense of perspective and societal relevance for projects that are much more technically driven. Sister projects should not be driven by confrontation (to another specific project) but are more about having a margin of freedom to challenge the orthodoxy, in the sense of 'constructive subversion.' Sister projects can be easily instrumentalised in the current H2020 system. One sentence can be added to most call texts requesting, e.g. that "proposals are also welcome for projects that critically address the topic described here." As such, these proposals would need to be evaluated through a different review process (see evaluation and reviews section below for our recommendations on the expansion of the current triad of evaluators to a larger committee to ensure different disciplinary perspectives are included in evaluations).

We also recognise that there is a need to *learn how to interact with different disciplines* as real life exercises. **Concertation meetings** (organised as 'unconferences') driven thematically by specific project outputs maybe useful in this regard (I.iii).

Finally, it is worth considering the development of evaluation committees as integral requirements to research activities. Rather than requiring multiple disciplinarity to be an active process within projects, we suggest that a more formalized structure could be created for such practices within the H2020 programme structures. The **creation of 'sounding boards'** consisting of researchers with experience in MDAs, that interact on a regular basis, may provide an interesting alternative (V.iii). These boards could sit across several projects, and would serve as a 'lighthouse' or a 'watchdog', ensuring that multiple disciplines are taken into consideration at specific points during project lifetimes (for example, specific milestones could perhaps be imposed on larger projects). This would put an MD approach at the top of the evaluation process, rather than in a box at the corner. It would also address the problem of hierarchies amongst disciplines. However, one major disadvantage of this scheme would be that it *places MD researchers in opposition to monodisciplinary researchers*.

The different mechanisms we have proposed above all work to promote useful MD interactions. They do so predominantly by recognising that these interactions can be more effective when carried out at different distances from key project objectives. Some projects ask questions which need direct interaction amongst different disciplines, and thus need to think about full integration of MD. Other projects are more suited to mono-disciplinary activities, but their outputs may require the 'sounding board' treatment. More broadly, topics raised in H2020 may require the 'sister project' approach described above.

3.2 Attitudes and aspirations

Multiple disciplinary research can only be as good as the environment that enables it. Successful engagement in multiple disciplinary research requires involvement, cooperation and high-level backing of funding agencies, of universities and other research communities, as well as of researchers themselves. MDAs are not the sole 'new' way of executing research, but do provide an alternative approach to solving broad complex societal challenges. Researchers who decide to engage in MDAs recognise this. Their aspirations and desires to understand, challenge and deal with these societal challenges should be acknowledged by the environment which supports them (including universities, funding agencies and other research communities). We need to find an appropriate set of indicators to measure excellence amongst these researchers, who may find it challenging to publish in journals that traditionally measure excellence. This needed support also includes practical problems associated with these border-transgressors: pension schemes, health insurance, career stability, and so on.

Our interviewees and workshop participants stress that there is a need to **establish positive attitudes towards MD** (II.i). Ideally, there should be a strong common appreciation for the value of multiple disciplinary research. This appreciation should not be presented as a requirement for *all* research, but should be considered as a positive characteristic of research for certain types of research questions. Indeed Section 3.1 above underlines the 'human factor' as a crucial element in multiple disciplinarity.

To that end, the needs for and benefits of MD research must be communicated to all above-mentioned stakeholders. Subsequently, whenever there is added value in engaging in multiple disciplinarity, the **research environment** should be adapted to make the most of it (Section 3.1 highlights the use of floating budgets; Section 3.3 mentions the role of an MD coordinator; II.ii). MDAs need to be incentivised and rewarded within research structures themselves. For example, universities and other academic communities could establish more interdisciplinary research groups, include MD aspects in their teaching curricula, and facilitate staff exchanges among research units. We believe MD needs to be integrated into all aspects of academic life: programmes/degrees (as early as the formative years), events, publications and journals.

Multiple disciplinarity would bear more fruits if **continuity** was ensured (II.iii). The endeavours above will only be successful if they are employed in a strategic, long-term manner. University programmes resulting in MD degrees and interdisciplinary research units cannot be established *ad hoc*, to serve one single MD idea. Running a multiple disciplinary journal needs long-term organisational and financial support beyond the lifetime of a research project. When MD research projects are successful, generating academic curiosity, their follow-up(s) should be encouraged. In any case, individual researchers from various disciplines should be able to interact after the conclusion of common projects.

3.3 Design and structure of projects

Multiple disciplinary approaches should be carefully developed, and not simply 'slung' together in response to a call. There should be opportunities for concertation, design and structuring the interactions between different disciplines outside of the traditional projects.

It must be recognized that *multiple disciplinarity comes at a price*, however. Multiple disciplinarity requires adequate resources: time, money and wo/manpower. These considerations need to be built in the design of both the project and the call. Time is necessary to build trust, explain and engage. Subject to evaluation criteria, H2020 could **encourage the inclusion of person months for multiple disciplinary engagement** in research projects (III.i). Two interviewees call for allocated time to understand the details of other partners' work packages. This would enable multiple disciplinary interaction on a continuous basis. In each of these processes, our workshop participants emphasize the importance of an **MD project coordinator** who encourages engagement and serves as a bridge between disciplines: the bridge scientist described in the literature review may provide a useful starting point for consideration when designing projects (III.ii).

Evidence provided by interviewees, which supports our findings from other study activities, has led us to believe that, in general, MD adds value in the **proposal writing and design stages of a project, and in the prototyping, testing and validation of products** (III.iii).

Project members should also make great effort to coordinate. This includes **coordinating terminology and encouraging a relatively large number of physical meetings** (III.i). In addition to encouraging this on a project level, we propose that the **CSA (Coordination and Support Action) may be a useful tool to engage a larger number of projects to share ideas in an 'unconference' setting**. However several sources have noted that financial resources must be provided for each project in order for this to be a productive endeavour. Furthermore, the CSA instrument will only be useful if it is large enough to analyse and synthesise findings from the research projects it is following, and if it has resources available to help these projects interact.

We highly recommend **taking entire research teams in a conclave at the beginning of a project**, in order to share ideas (I.iii). This helps build trust, which is necessary.

Participants at our April workshop noted that H2020 currently engages a broad range of actors, from universities to companies. This leads to specific partners receiving 'labels' and being treated as a representative agent of a specific community (the "social scientist partner", "the computer programming partner", "the environmentally aware partner", ...). We propose that H2020 actively encourages technical partners to engage their 'in-house' social scientists, who can then speak the language of the DSSH community, and interpret/translate for the technical partners. Another possibility is to insist that common workspaces for interaction in research projects are implemented. Several interviewees note that it is difficult to work interdisciplinarily when sitting in different locations. This brings up the nature of international project work, and the need for physical meetings, particularly at the beginning of research projects. We deem it necessary to **encourage research stays ("twinning") across partners within project consortia** (III.i).

3.4 Presenting MDAs in research calls

Our research has shown that there is a need for MDAs to be included in call texts. MDAs should be referred to in the call texts as and where it is appropriate to do so. In Sections 3.1 and 3.3 above we identified the key areas where projects need to take MDAs into consideration. At the same time, our validation workshop participants emphasized that we need to leave room for consortia to propose innovative ways of approaching multiple disciplinarity. In the call texts themselves, we feel that there should be an incentive structure to encourage consortia to actively think about exactly what the added value is of their MDA, should they choose to develop one. Given the extra effort (in learning, trusting, growing together), we suggest that **calls should propose an additional budget line for projects which successfully meet the (more stringent than current) criteria for interacting between disciplines** (IV.iii).

Given that some of the major positive consequences of incorporating MDAs into a research project are the levels of knowledge creation, potential increase in sustainability/take up/success of the project, we propose that **projects that engage in MDAs are rewarded if new innovations do emerge by the end of the project** (IV.ii).

All social science respondents to our study activities noted that there was a paucity of social science representation in the drafting of call texts and evaluation of projects. **Affirmative action may be necessary to redress this imbalance** (IV.i). In this way, we may start to de-emphasise the technological tool and focus more on the societal outcome and impact of the development of specific tools.

Another way of potentially addressing the noted imbalance in the call texts may be to link the technological solutions not only to the Digital Agenda for Europe, but to the broader higher level political aims of the EU: if **different Commission DGs were engaged in drafting up the call texts at an early stage**, then maybe the division between technology and policy may not be so stark.

3.5 Proposal evaluations and project reviews

Concerning proposal evaluations, we note from insights gathered in Vilnius and at our April workshop that many projects are artificially structured with MDAs for the purposes of the evaluation process (i.e. in order to receive financing). We propose that a smart approach would require proposers to **convincingly persuade evaluators of how the consortium intends to work together in an MD fashion**, should they choose to do so (III.iv). They will need to bear in mind the points that have been raised in Section 3.3 above. In parallel we believe it is necessary to communicate that multiple disciplinarity will be subject to specific evaluation in project proposals (V.iv).

As reported from our workshop and brainstorming sessions with external experts, we suggest that the **team of evaluators for proposals should be comprised of individuals from different disciplines**, effectively subjecting the evaluation of proposals to a multidisciplinary committee (V.ii). Project proposals should be evaluated by a team of individuals from different disciplinary backgrounds even if the project itself does not claim to be following a multiple disciplinary approach. For the

purposes of proposal evaluation, this may mean that concertation meetings are broadened from the current triad to a larger committee. This may result in the evaluation process taking more time.

Concerning project reviews, our recommendation is similar. The current process consists of two or three individual external experts reviewing a project on a fixed and regular basis. We propose to split the project review process into two separate activities. On the one hand, there should be an **administrative review**, to ensure that the project is being executed according to the terms agreed prior to contract signature. On the other hand, a more **public evaluation process of the substantive elements** of the research project should take place (V.i). Public dissemination of project results (where possible) would enable a larger committee of individuals to review the project's outputs from their own disciplinary perspectives.

We would also encourage the funding programmes to organize opportunities for projects to be more reflexive, i.e. providing them with opportunities to self-review, perhaps during concertation meetings with other projects with similar themes.

3.6 Communicating MDAs in H2020 to the research community

Our final recommendation for the smart approach concerns communication. It is imperative that the Commission make use of the proposers' days to communicate 'what' a smart approach is and what the challenges and benefits are for MDA-based research (VI.iii). **The communication task should take the form of an information-sharing task too, with good MDA practices being shared with the rest of the H2020 community** (VI.i). Subject to further analysis of successful MDA projects, we recommend the development of a dedicated webpage. Review of MDA successes and failures should additionally become a key element of the (interim) reviews of the H2020 programme (VI.ii).

Furthermore, **good communication and common understanding**, i.e. to *avoid 'speaking different English'* are crucial for effective exchange of knowledge, which is a precondition for efficient multiple disciplinarity. The empirical evidence gathered in this study underlines the need to **deliberately make translation exercises and create a common vocabulary**. Bridge scientists (or boundary persons) play an important role in explaining terminology and methods to project partners. Some interviewees also *encourage the use of visual tools and boundary objects*, in order to make processes understandable to the entire research team. Examples of boundary objects are scenarios, personas, social requirements and mock-ups. Boundary objects help researchers take distance from their disciplinary context to explain their rationales, workprocesses and results to a wider audience.

3.7 Target audience

We would like to restate that our investigations do not lead us to think that the European Commission itself is the sole actor responsible for ensuring the success of MDAs in H2020. We believe that our smart approach may also be relevant to national and other scientific funding agencies. Researchers themselves have responsibility to promote and develop innovative ways of providing spaces for

successful interaction between disciplines, and **communication of MDAs for policy research is, and should be, a two-way process** between (and amongst) researchers and policymakers. We have identified several different groups of actors for whom the smart approach is relevant. The following table highlights the target audience for each aspect of the smart approach.

Audience	European Commission, national and other scientific funding agencies	Individual researchers	Proposal evaluators	Project reviewers
Engagement dynamics	X	X	X	X
Attitudes and aspirations		X	X	
Project design and structures		X		
Call text formulation	X			
Evaluations and reviews	X		X	X
Communicating MDAs	X	X		

Table 2 Audience for specific elements of the smart approach

Annex A: Basis and evidence for the smart approach

Elements of the smart approach	Annex:	Literature	Survey analysis	Case analysis	Interviews	ICT2013 discussions	April workshop	Validation workshop
Engagement dynamics (I)								
Uncontrolled interactions – floating budget (I.i)						X	X	
Sister projects (I.ii)					X	X		X
Concertation meetings – ‘unconferences’ (I.iii)					X		X	
Attitudes and aspirations (II)								
Positive attitude towards MD (II.i)				X	X			X
MD research environment (II.ii)							X	X
Continuity of MDAs (II.iii)	X							X
Project design and structures (III)								
Encourage MD engagement – initial exercises, research stays and regular meetings (III.i)	X	X		X	X		X	X
MD project coordinator (III.ii)		X			X		X	X
Clear identification of where MD adds value within projects (III.iii)	X						X	
Evidence of coordination efforts between different disciplines (III.iv)	X				X		X	X
Call text formulation (IV)								
Enhance SSH participation in drafting of call texts (IV.i)		X			X			
Prizes for MD solutions to societal challenges (IV.ii)					X	X		
Additional project budget for MD projects (IV.iii)					X		X	
Proposal evaluations and project reviews (V)								
Public reviews and encouragement for reflexive self-reviews (separate from Admin Review) (V.i)						X		
Proposal evaluations executed by representatives from different disciplines (V.ii)	X							
MD ‘sounding boards’ (‘the lighthouse’) (V.iii)						X		
MD-specific evaluation in project proposals (V.iv)								X
Communicating MDAs to the research community (VI)								
Sharing best practices (VI.i)	X							X
MDA review in (interim) H2020 review (VI.ii)								X
Proposers’ days (VI.iii)				X		X		

Table 3 Basis and evidence for the smart approach

Annex B: literature review

B.1 Introduction

The following pages outline some of the literature reviewed in the course of executing this study. It is provided as an annex in order to help the reader situate themselves, and to understand how our thoughts have been inspired.

A simple bibliographic search of any scholarly database on topics relating to multiple disciplinary approaches (MDAs) will bring up a huge number of results.² Indeed, MDAs appear to be discussed in most corners of the academic world, from Nursing Studies to Geography and beyond. This literature review attempts to provide an overview of a segment of the current scientific knowledge about the interaction between different disciplines (multiple disciplinary approaches, or MDAs), with a focus on the operationalization of research projects. We also examine the questions of digital society and the impact of technology on the core issue of privacy. The literature covered here deals explicitly with issues of disciplines, multiple disciplinary approaches, and the way in which these are framed, structured, contested and further developed. Drawn mainly from scientific journals and other academic publications, this literature maps out the diversity in interactions between disciplines, and shows how many different actors experience challenges in justifying and also executing multidisciplinary work. The literature we examined also attempts to explain when and why multiple disciplinary approaches are useful. At times, the literature accepts MDAs in and of themselves as being normatively worthwhile, and yet we also identified a body of writing that raises questions about much of this dogmatic and often unquestioned belief in the positive nature of MDA-driven research.

B.2 Disciplines as structuring devices

Literature covered:

- Castán Broto, V., Gislason, M. & Ehlers, M.-H., 2009. Practising interdisciplinarity in the interplay between disciplines: experiences of established researchers. *Environmental Science & Policy*, 12(7), pp.922–933.
- Chettiparamb, A., 2007. Interdisciplinarity: a literature review. ... *Teaching and Learning Group*.
- Jolly, L. & Kavanagh, L., 2009. Working out and working in critical interdisciplinarity. *Australasian Association for Engineering*
- Forman, P., 2012. On the Historical Forms of Knowledge Production and Curation: Modernity Entailed Disciplinarity, Postmodernity Entails Antidisciplinarity. *OSIRIS*, 27(1), pp.56–97.
- Alvargonzález, D., 2011, *International Studies in the Philosophy of Science*, 25(4), pp.387–403.
- Hedtke, R., 2006. The Social Interplay of Disciplinarity and Interdisciplinarity. Some Introductory

² A search of the University of Amsterdam's digital catalogue for the terms "inter* trans* multi* disciplinarity" brought up 1,711 hits of available resources.

Remarks. *JSSE-Journal of Social Science Education*, 5(4).

Jacobs, J., 2013. *In defense of disciplines: interdisciplinarity and specialization in the research university*, University of Chicago Press.

Molloy, J. C. (2011). The Open Knowledge Foundation: Open Data Means Better Science. *PLoS Biology*, 9(12), e1001195.

Taylor, M.C., 2009. End the university as we know it. *New York Times*, p.A23. Available at: <http://www.nytimes.com/2009/04/27/opinion/27taylor.html>.

In the literature on multiple disciplinary approaches (MDAs) in research, a few key assumptions are made concerning the conceptualisation and nature of disciplinary boundaries. Certain literatures treat disciplines as 'institutions' (Castán Broto, Gislason, & Ehlers, 2009), whereas others treat them in a more traditional sense; as 'structuring modes for academic practice' (Chettiparamb, 2007, p. 2). Jolly and Kavanagh state that disciplines 'identify some kind of phenomenon in the world and make that the focus of their interest' (Jolly & Kavanagh, 2009). 'Disciplines are institutions oriented not to the provision of a practical service but to the production and curation of a distinctive body of knowledge' (Forman, 2012, p. 60). Forman's article, from which this citation comes, describes how disciplinary divisions proved useful as a tool of 'modernity,' and were successful in the fifty years following the end of World War I, where - it is asserted - the production of knowledge was best done in discrete units.

In the literature, there is general agreement over what a discipline is and how it has become a fundamental building block of scientific activity in academia and beyond. Most individuals who go through higher education are trained in certain disciplines and continue to advance their careers in those disciplinary frameworks: thus, for them, the idea of discipline is like a 'professional home'. This line of thought on disciplines is advanced by Leo Apostel. He claims: "A discipline does not exist. A science does not exist. There are persons and groups practicing the same science or the same discipline (Apostel, cited in (Chettiparamb, 2007, p. 4))." The idea that disciplines are socially constructed is brought to the fore in literature that is now emerging in the mainstream (see Alvargonzález, 2011)

Of course, Jacobs, Alvargonzález, and Forman have emphasized that disciplines exist for a reason. Even though we may critique the basis for these social constructions, there is little point in denying that they have served a purpose for many decades (centuries!), and will probably continue to do so. This point is emphasized in a rich *Defence of Disciplines*, Jerry Jacobs states "disciplines reflect a rough and admittedly imperfect response to the need to divide intellectual domains. With over twenty-eight thousand peer-refereed journals currently being published and hundreds of scholarly societies convening regular meetings, no new organizational arrangement for academia can hope to avoid some form of specialization." (Jacobs, 2013).

Disciplines should not also be treated as static objects. They are constantly evolving. Hedtke argues that "Historically, the organisation of academic disciplines seems to be subjected to a forceful global process of differentiation which produces ever new sub-disciplines from of a mother discipline" (Hedtke, 2006: 2).

This increased shift towards specialization in (sub-)disciplines has also been shown to be a limiting characteristic of mono-disciplinarity, and in part, the rise of MDAs is seen as a response to this 'nicheification' (Jacobs, 2013). A debate was sparked in academia following the publication of a New York Times Opinion piece by Mark Taylor in 2009, which criticized the current status of universities and their disciplinary structures as we

know them (Taylor, 2009). His article fuelled a discussion that focused on the benefits and disadvantages of ‘problem-driven learning’ as opposed to learning carried out in discipline-based departments. Similarly, the emergence of debates around ‘open knowledge’ are forcing us to dramatically rethink the way that disciplines act as the harbours of common wisdom (Molloy, 2011).

B.3 Multiple disciplinary approaches

Literature covered:

- Balsiger, P.W., 2004. Supradisciplinary Research Practices : History, Objectives and Rationale. *Futures*, 36(4), pp.407–421.
- Barry, A., Born, G. & Weszkalnys, G., 2008. Logics of interdisciplinarity. *Economy and Society*, 37(1), pp.20–49.
- Hedtke, R., 2006. The Social Interplay of Disciplinarity and Interdisciplinarity. Some Introductory Remarks. *JSS- Journal of Social Science Education*, 5(4).
- Porter, A.L. & Rafols, I., 2009. Is science becoming more interdisciplinary? Measuring and mapping six research fields over time. *Scientometrics*, 81(3), pp.719–745.
- MacMynowski, D.P., 2007. Pausing at the brink of interdisciplinarity: power and knowledge at the meeting of social and biophysical science. *Ecology and Society*, 12(1).
- Eddy, S.R., 2005. “Antedisciplinary” Science. *PLoS Computational Biology*, 1(1), p.e6.
- Huutoniemi, K. et al., 2010. Analyzing interdisciplinarity: Typology and indicators. *Research Policy*, 39(1), pp.79–88.

Whereas ‘disciplines discipline disciples, [and ensure that certain] disciplinary methods and concepts are used rigorously’, ‘ideas of interdisciplinarity and transdisciplinarity imply a variety of boundary transgressions, in which the disciplinary and disciplining rules, trainings and subjectivities given by existing knowledge corpuses are put aside or superseded.’ (Barry, Born, & Weszkalnys, 2008: 20–21).

Several different approaches to research that integrate disciplines can be identified in the literature. Whilst each of them have their own specific meaning, they are sometimes used interchangeably in the literature and beyond academic circles. We have highlighted their usage in specific literatures in this section of the literature review. ‘**Supradisciplinary** scientific practices’ is used as a term “for all forms of scientific collaboration where the field of a single discipline is transgressed” (Balsiger, 2004).

Multidisciplinary (or cross-disciplinary) research endeavours ‘draw on knowledge from different disciplines, but stay within their boundaries’. Jolly *et al* formulated multidisciplinary research as an additive endeavour: ‘this leaves each of the contributing disciplines to work within their own worldview with their own standard methods, and this is an approach often seen in attempts to incorporate engineering and the social sciences within a single project’ (Jolly & Kavanagh, 2009: 710).

Interdisciplinary research endeavours ‘analyse, synthesise and harmonise links between disciplines into a coordinated and coherent whole’ (Choi & Pak, 2006). Interdisciplinarity needs to be treated at different levels: ‘research, academic education, teaching and learning at schools, the general competence of understanding the social world (social science literacy) and last but not least real world problems which do not present themselves in fine cut disciplinary frames’ (Hedtke, 2006: 3). Interdisciplinarity is

regarded as an complicated issue and at the same time a cherished and popular demand' (Hedtke, 2006: 1). "Understood as **knowledge integration**, interdisciplinarity is not the opposite of specialization." (Porter & Rafols, 2009: 720).

Even when things may be considered interdisciplinary by various pockets of academicians, there are sometimes startling omissions in the types of disciplines that are included. Dena MacMynowski notes that interdisciplinarity has been a growing issue in the social sciences as well as the biophysical sciences, and yet 'the two discussions are running in parallel with stunningly little crossover' (MacMynowski, 2007: 3). But at the same time, interdisciplinarity can be seen as just one step towards the creation of new disciplines: 'Interdisciplinary science is just the embryonic stage of a new discipline. To value interdisciplinary science for its own sake is to value history over progress - that is, to value people's past training more than their current work' (Eddy, 2005: 3). This critique of the nature of interdisciplinarity is remarkable in the sense that it questions the effectiveness of thinking about scientific progress in terms of disciplines.

In contrast, **interdisciplinary*** (note that this is the term used by the authors, inclusive of the asterisk) research is based on active interaction across fields. This interaction takes place not only in the framing of research problems and coordinating knowledge flows between fields, but also in the execution of research and the formulation and analysis of results. It is thus legitimate to talk about "interdisciplinary interpenetration" (Fuller, 1993) or "interdisciplinary cognition" (Nikitina, 2005). Interdisciplinary* research often integrates separate bodies of specialized data, methods, tools, concepts, or theories, in order to create a synthetic view or common understanding of a complex issue or problem; it goes beyond a simple sum of the parts (Huutoniemi, Klein, Bruun, & Hukkinen, 2010: 83 emphasis added).

Transdisciplinary researchers 'integrate the natural, social and health sciences in a humanities context, and transcend their traditional boundaries' (Choi & Pak, 2006). "Transdisciplinary research is an approach to problem-solving at the meta-disciplinary level where researchers work collaboratively to define the research problem, establish a research design to jointly implement and analyze, and propose multidimensional responses to create a joint product" ("Transdisciplinary Research on Environmental Governance," 2014).

Ontological questions are key to the discussions around disciplinary practices: can research groups themselves transcend disciplines, or can only the object of research be accorded this name? Therefore, talk of MDAs must take into consideration the central object of study: are we talking about the research object itself, or the way in which research is carried out? (Lawrence & Despres, 2004: 400). This has inevitable consequences for the smart use of MDAs and the subsequent shaping of projects.

In an attempt to regularize the differences between these terms, Choi and Pak suggest that multiple disciplinary endeavours can be seen on a **spectrum or continuum**, ranging from multidisciplinary (when desirable to gain insight from different disciplines without challenging boundaries), via interdisciplinary (optimal when desirable 'to generate new common methodologies, perspectives, knowledge, or even new disciplines'), to transdisciplinary (optimal when desirable 'to transcend the disciplinary boundaries to look at the dynamics of whole systems in a holistic way') (Choi & Pak, 2006).

The definitions raised in the literature are evidently contestable, and have promoted a lot of discussion amongst specialists in the field as the following sections of this literature review reveal.

B.3.1 The mantra driving the call for MDAs

Literature covered:

- Barrett, B.D., 2012. Is interdisciplinarity old news? A disciplined consideration of interdisciplinarity. *British Journal of Sociology of Education*, 33(1), pp.97–114.
- Chettiparamb, A., 2007. Interdisciplinarity: a literature review. ... *Teaching and Learning Group*.
- Thompson Klein, J., 1990. *Interdisciplinarity: History, Theory, and Practice*, Detroit, MI: Wayne State University Press.
- Jacobs, J.A. & Frickel, S., 2009. Interdisciplinarity: A Critical Assessment. *Annual Review of Sociology*, 35(1), pp.43–65.
- Jahn, T., Bergmann, M., & Keil, F. 2012. Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics*, 79, p. 1–10.
- Strathern, M. 2006. A community of critics? Thoughts on new knowledge*. *Journal of the Royal Anthropological Institute*, 12(1), pp. 191–209.

The previous section highlighted where MDAs can potentially add value to research processes and outputs, yet we also noted a large amount of literature that focused on the unquestioning application of MDAs in research. A ‘mantra’ for second (research council) and third-stream (private sector) funding has often focused on the importance of interaction between different disciplines. Scholars often refer to an OECD report published in 1972 which identified several reasons as to why MDAs are carried out (Chettiparamb, 2007: 26–28). These focus on motives and goals of research, and claim that interdisciplinarity provides a key opportunity for ‘research’ to contribute to solving real-world problems’. This sets the standard for the rationale behind calls for support of MDAs. Thompson Klein echoes the OECD publication’s goals. She states:

Educators, researchers, and practitioners have all turned to interdisciplinary work in order to accomplish a range of objectives:

- *to answer complex questions;*
 - *to address broad issues;*
 - *to explore disciplinary and professional relations;*
 - *to solve problems that are beyond the scope of any one discipline;*
 - *to achieve unity of knowledge, whether on a limited or grand scale.*
- (Thompson Klein, 1990: 12)

In another, later, publication, Julie Thompson Klein elaborated on the definition of complexity in the ‘real world’ and shows how MDAs are almost necessary for ‘good’ research: “The problems of society are increasingly complex and interdependent. Hence, they are not isolated to particular sectors or disciplines, and they are not predictable. They are emergent phenomena with non-linear dynamics, uncertainties, and high political stakes in decision making” (Thompson Klein, 2004).

Although these descriptions of the benefits of implementing MDAs appears to have become ‘mainstream’ in most institutional approaches to multidisciplinary, a cursory glance at more recent literature shows that these desired outcomes are challenging to achieve. MDAs are often used simply to fulfil institutional criteria for research funding.

Authors such as Jahn et al have gone as far as to say that there is a lack of quality standardisation for different MDAs, leading to the marginalization of the 'real value of MDAs, and mainstreaming the superficial activity of putting different disciplines together with no view to the potentials that can be made (see next subsection) (Jahn, Bergmann, & Keil, 2012).

Strathern links the rise of the 'management' ethos in research universities to ideas of multidisciplinary. She notes that these discussions have been present since the late 1950s, emerging from a survey of social sciences in the United States (Strathern, 2006: 197).

Jacobs and Fricke question the value of interdisciplinarity in a 2009 publication where they state: "the widespread attention that administrators, funders, and faculty alike are giving to interdisciplinarity—and the intensity of the debates that attention has generated—is striking given the fact that relatively little research on many of the underlying issues has been conducted." (Jacobs & Fricke, 2009: 44). Barrett (2012: 103) takes the argument one step further, and argues that interdisciplinary work that focuses on solving real-world problems actually runs counter to some fundamental objectives of science (quest for the truth through building up of evidence). He justifies his argument by citing the work of Moore: "The knowledge produced on the basis of problem-focused approaches 'is of limited general application by virtue of its initial contingency and ad hocness and is low in "transportability". Knowledge integration and abstraction requires a deeper "metatheoretical" language of a disciplinary nature".

Another point that can be drawn from works of certain scholars in the social sciences is that we can not simply treat all social sciences and humanities as one entire block, particularly when it comes to research concerning ICTs. The heterogeneity of the social sciences means that there are some disciplines within this large family that are more amenable to MDAs than others; for example, geographers.

B.3.2 The real value of MDAs

Literature covered:

Klabbers, J., 2010. Counter-Disciplinarity. *International Political Sociology*, 4(3), pp.308–311.

Saur-Amaral, I. & Kofinas, A., 2010. Multidisciplinary collaborations in pharmaceutical innovation: a two case-study comparison. 7(3), pp.131–153.

Strathern, M. 2006. A community of critics? Thoughts on new knowledge*. *Journal of the Royal Anthropological Institute*, 12(1), pp. 191–209.

Getting beyond the mantra that encourages the unquestioning shift towards MDAs is often quite difficult to do, in terms of finding literature that tries to address the specific value of MDAs to policy-relevant research. This subsection covers some of the limited literature that goes beyond the mantra.

One of the key questions this study addresses concerns the actual value of working across disciplines. Given that we have identified a trend that treats MDAs as a panacea for everything, we actually need to address the question: what value can MDAs bring to policy-relevant research?

Whilst the argumentation emerging from literature that is described in the previous section reveals the 'mantra' of MDAs in research projects, there are some benefits to be

gained from crossing disciplines. This tension between the blind leap and the careful step into MDAs is highlighted by Klabbers, who states:

Much of the drive towards inter-disciplinarity stems from the desires of funding agencies who tend to use the natural sciences as their models. It may indeed be the case (I am not qualified to judge) that cooperation between chemists and biologists can result in interesting and relevant biochemistry, or that cooperation involving physicists and engineers may result in useful insights. Indeed, the science historian Thomas Kuhn famously pointed out that scientific breakthroughs are often accomplished by newcomers to the field: these are not yet captured by the operative paradigms (Klabbers, 2010: 308).

The following table, drawn from Saur-Amaral and Kofinas' work on collaboration in pharmaceutical innovation, shows the distinct values of both mono- and multi-disciplinary research activities. (Saur-Amaral & Kofinas, 2010). One key issue worthy of highlighting in this table is the circular nature of multidisciplinary research: it has a potential to feedback into the source disciplines of the participants, thereby increasing disciplinary knowledge as well.

	Well defined approach known instruments	Complex approach unknown instruments	Efficiency	Conflict	Creativity	Impact on disciplinary knowledge
Disciplinary	Appropriate	Less appropriate	High	Less probable	Limited to knowledge domain	Limited, relatively to the existing paths
Multi-disciplinary	Less appropriate	Appropriate	Low	Very probable	High, goes beyond knowledge domains	High possible impact, challenging existing paths

Source: Saur-Amaral and Kofinas, 2010

Strathern refers to benefits emerging not from 'multidisciplinarity', which she sees as the 'management' of knowledge creation, but rather from the new disciplinary possibilities that can emerge from interactions between disciplines; she argues for division and proliferation, thereby creating multiple and indeterminate futures. This is where Strathern sees new benefits emerging (Strathern, 2006: 197). As an anthropologist, she sees a clear creative potential generated by MDAs: "instead of generating disagreement and multiplying future possibilities by informed comment from within, interdisciplinary conversations hold out the hope of new sources of synergy" (Strathern, 2006: 201). For authors such as Strathern, the benefit of, and richness in MDAs comes from the potentials that it holds for greater conversations between different experts, and the potentials that holds for knowledge creation.

B.3.3 Measuring MDAs

Literature covered:

Buter, R.K., Noyons, E.C.M. & van Raan, A.F.J., 2010. Identification of converging research areas using publication and citation data. *Research Evaluation*, 19(1),

pp.19–27.

- Chua, A.Y.K. & Yang, C.C., 2008. The shift towards multi-disciplinarity in information science. *Journal of the American Society for Information Science and Technology*, 59(13), pp.2156–2170.
- Dickens, P., 2003. Changing our environment, changing ourselves: critical realism and transdisciplinary research. *Interdisciplinary Science Reviews*, 28(2), pp.95–105.
- Dini, P., Iqani, M. & Mansell, R., 2011. The (Im)possibility of Interdisciplinarity: Lessons from Constructing a Theoretical Framework for Digital Ecosystems. *Culture, Theory and Critique*, 52(1), pp.3–27.
- Eddy, S. R. 2005. “Antedisciplinary” Science. *PLoS Computational Biology*, 1(1), e6.
- Laudel, G. 2006. Conclave in the Tower of Babel: how peers review interdisciplinary research proposals. *Research Evaluation*, 15(1), pp. 57–68.
- Leydesdorff, L., 2007. Betweenness centrality as an indicator of the interdisciplinarity of scientific journals. *Journal of the American Society for Information ...*, 58(9), pp.1303–1319.
- MacMynowski, D.P., 2007. Pausing at the brink of interdisciplinarity: power and knowledge at the meeting of social and biophysical science. *Ecology and Society*, 12(1).
- Morillo, F., Bordons, M. & Gómez, I., 2003. Interdisciplinarity in science: A tentative typology of disciplines and research areas. *Journal of the American Society for Information Science and Technology*, 54(13), pp.1237–1249.
- Porter, A.L. & Rafols, I., 2009. Is science becoming more interdisciplinary? Measuring and mapping six research fields over time. *Scientometrics*, 81(3), pp.719–745.

The research community, as a collection of individuals who produce outputs according to institutional desiderata, also faces challenges in implementing MDAs. One particular experience within the context of an EU FP6-funded project, taught the participants that developing new, unified, understandings across different disciplines was impossible, but that interaction between disciplines is valuable:

Theoretical interdisciplinarity and applied research, as we discovered through the process of building a DE framework that could hold a variety of often conflicting epistemological positions, arguably benefits not from unification but from difference, creatively integrated, which drives innovation, communication, and social dynamics (Dini, Iqani, & Mansell, 2011: 24).

The major attribute of MDAs here is not the emergence of a common way of understanding (interdisciplinarity), but rather a mutually beneficial exercise, which allows researchers to continue in mono-disciplinary exercises, but learning to communicate their findings to those from other disciplines. An awareness of difference and specificity thus emerges. This awareness of difference is useful in helping to conceive how individual disciplines can help solve real-world problems. Before such complex dynamics can be put into place, however, apathy and prejudice towards different disciplines needs to be reduced (following (Dickens, 2003: 97)): social scientists must come to terms with reality: "beyond the postmodernist and poststructuralist fog there must be a real, material, reality which is having real, material, effects. It is irresponsible of social scientists to simply dismiss science, often a science of which they have little understanding themselves."

In research programmes, despite a clear lauding of integration of different disciplines, efforts towards this interaction have not been systematically recorded in the scientific literature. Thus there is little in the way of understanding why and how these efforts have not been truly successful until now. Measurement of multidisciplinary remains for the most part, a highly quantitative affair.

There are several simple mechanisms in place for identifying the existence of MDAs in research programmes. First of all, there is the output mechanism, which provides a simple way of checking joint publication and citation data (Buter, Noyons, & van Raan, 2010; Chua & Yang, 2008). These evaluations of interdisciplinary research in journals (MacMynowski, 2007) can provide useful indicators as to the convergence of different disciplines towards common research topics.

Mapping of distances between disciplines is often done by using journal citation indices. Such work has been carried out by Porter et al in 2009, Ismael Rafols in 2014 (Porter & Rafols, 2009), Morillo et al in 2003 (Morillo, Bordons, & Gómez, 2003), and Leydesdorff et al in 2007 (Leydesdorff, 2007).

The literature described above leads us to understand that there are disciplines that are naturally inclined to work with each other. Hard, or exact, scientists often find it easier to share experiences together. They are often welcoming of 'interdisciplinary activities' between different branches of similar 'sciences' as well. In other words, they are far more open to calling their interactions interdisciplinary: however the link towards the social sciences and humanities is often less easier to achieve.

Finally, we turn to the evaluation of interdisciplinary research projects, as a key element of measurement of the level of integration across disciplines. Part of the evolving situational context of second-stream (i.e. public-funded) project lies in the rigorous review process undertaken. This takes place at two stages in the project. The first time is carried out in the evaluation of the proposal phase, and then the project is evaluated during its lifetime, generally once per year. Both evaluation moments are problematic for MDAs as they are currently perceived. First of all, evaluation of MDAs in the project proposal phase can only evaluate proposed methods, consortia and expected outcomes. Given that we have identified MDAs as being anything but static, there are challenges as to how to identify beneficial synergies in such an evaluation phase. Evaluation of research executed through an MDA also poses large problems (Laudel, 2006). In *Conclave in the Tower of Babel*, Laudel analyses the challenges for review of interdisciplinary research proposals by peer reviewers, highlighting the need not only for innovation in research presentation, but also in the ways in which reviewers partake in "enforced learning" (Laudel, 2006: 67). As Eddy states:

if your grant proposal includes statistical analysis, your reviewers shouldn't be acting as enforcers requiring you to have a card-carrying statistician as a collaborator. Maybe in your narrow area, you know how to do the relevant statistics as well as any formally trained statistician (Eddy, 2005: 4).

B.4 MDAs: the anthropological element

Literature covered:

- Antikainen, M., Mäkipää, M., & Ahonen, M. (2010). Motivating and supporting collaboration in open innovation. *European Journal of Innovation Management*, 13(1), 100–119.
- Bruce, A. et al., 2004. Interdisciplinary Integration in Europe: The Case of the Fifth Framework Programme. *Futures*, 36(4), pp.457–470.
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- Dutton, W., Carusi, A. & Peltu, M., 2006. Fostering Multidisciplinary Engagement: Communication Challenges for Social Research on Emerging Digital Technologies 1. *Prometheus*, 24(2), pp.129–149.
- Forte, A., & Lampe, C. (2013). Defining, Understanding, and Supporting Open Collaboration: Lessons From the Literature. *American Behavioral Scientist*, 57(5), 535–547. doi:10.1177/0002764212469362
- Holick-Jones, T. & Sime, J., 2004. Living on the Border: Knowledge, Risk and Transdisciplinarity. *Futures*, 36(4), pp.441–456.
- Watters, E., 2013. We Aren't the World. *Pacific Standard*, pp.1–9. Available at: <http://www.psmag.com/magazines/pacific-standard-cover-story/joe-henrich-weird-ultimatum-game-shaking-up-psychology-economics-53135/>.

Technologists and researchers from different disciplines often face many challenges when attempting to collaborate. Educational structures that encourage depth and focus often fail to teach broad awareness of what policy-relevant research is aimed at achieving: namely a greater understanding, and proposals for resolution, of key societal challenges. This is also noted in the way that existing multidisciplinary researchers refer to work from 'beyond their borders' without often questioning the statements made. The case can be made by looking at anthropologists who -until recently- had taken fundamental preconceptions from other disciplines without testing them in their field research (Watters, 2013). Compare this with economists, who consistently referred to psychological research about rationality in human beings without challenging the assumptions made about psychological behaviour of wo/mankind. These rational-choice assumptions are now becoming less commonplace due to the rise in the predominance of behavioural economics, but it is not an equal or well-distributed shift.

In recent decades, the recognition that it is necessary for research communities to interact more closely with public policy has received large boosts. In many EU countries and beyond, even fundamental scientific research organisations and foundations are now actively supporting multidisciplinary research programmes. This is because multiple disciplinary approaches can be useful to solve real world problems, which are often (if not always) subject to complexity. Multiple disciplinary approaches can help address old problems with new solutions due to the different perspectives that can be brought to light (Choi & Pak, 2006). Such discussions have also been continued in light of experiences in open innovation and open collaboration (see Antikainen *et al*, 2010; Forte & Lampe, 2013). Such 'border work' can be useful in bringing new solutions to light for highly complex problems, but does not necessarily come easy to researchers who have been trained and are incentivised by disciplinary fragmentation (Holick-Jones & Sime, 2004).

In the field of ICT research, divisions between disciplines, particularly those considered 'soft sciences' and 'hard sciences' are seemingly very difficult to overcome, when critically analysing the outcomes of interactions:

Major divisions between disciplines such as psychology, sociology and economics arise from their different understanding of the factors shaping technological change and its social implications. Overlaying these divides are methodological differences, such as between formal modellers (e.g. game theorists), quantitative empirical researchers (e.g. survey researchers) and qualitative researchers (e.g. ethnographers). But it is the gulf between computer scientists and other relevant engineers, technologists and scientists, on the one hand, and social scientists on the other that was seen as the crucial factor facing multidisciplinary collaboration in this area (Dutton, Carusi, & Peltu, 2006: 137).

Several researchers have highlighted one of the perceived problems in conducting interdisciplinary research. This is due, in part, to the desire and need to develop common language/terminology for the purposes of the research projects. These exercises are costly, and yet are not valued highly enough by funders and peers who are outside of the specific project activities. They can lead to communication issues within the consortium, research institution structures and problems in mutual attitudes across disciplines (Bruce, Lyall, Tait, & Williams, 2004: 464).

You have always something new to learn. There are several points in common in different disciplines which are not conceived at the beginning of the research work. Sometimes results in a given discipline would be much better if another point of view (discipline) was involved from the very beginning (Bruce et al., 2004).

B.4.1 The researcher and MDAs

Literature covered:

- Bozeman, B., & Gaughan, M. 2011. How do men and women differ in research collaborations? An analysis of the collaborative motives and strategies of academic researchers. *Research Policy*, 40(10), pp. 1393–1402.
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- Rhoten, D., & Pфирman, S. 2007. Women in interdisciplinary science: Exploring preferences and consequences. *Research Policy*, 36(1), pp. 56–75.
- Taylor, M.C., 2009. End the university as we know it. *New York Times*, p.A23. Available at: <http://www.nytimes.com/2009/04/27/opinion/27taylor.html>.

People who carry out research in MDA-driven processes are important. Their own goals and motives are important. These have been referred to as ‘bridge scientists’ (Chettiparamb, 2007: 28). A ‘bridge researcher’ is someone who crosses disciplines through their research activities. Such individuals can help bring together multiple disciplines to deal with one research question. This can be someone who is a new entrant to an academic field, someone who sits outside of ‘traditional’ academia, or someone is so well established that they do not need to worry about achieving high-level publications in mono-disciplinary journals. They appear to be necessary for multidisciplinary projects to work. But this is not as easy as it seems. Notably:

In social sciences at least, the young scholars feel compelled to follow the beaten path of a single disciplinary and know very well that drawing too much on interdisciplinarity or even transdisciplinarity is a punishable offence. Later, at the height of their career and afterwards scholars of social sciences are often much more open for neighbouring disciplines and even for calling disciplinary borders as such into question (Hedtke, 2006: 2).

Similarly, “scientists who leave the safe haven of their home discipline to explore the uncharted territory that lies outside and between established disciplines are often punished rather than rewarded for following their scientific curiosity (Shapiro, 2014: p. 1). The Scientific Journal ‘Nature’, one of the havens for certain types of MDA, published an opinion piece in 2010 which stated: “In spite of the hype, crossing disciplinary boundaries is risky. True interdisciplinary work requires expertise in several fields, which is difficult to achieve and accrue. So it is easy to be dismissed as a jack of all trades and master of none, especially as a postdoc.” (Paglieri, 2010).

Of particular interest in this context is the gender issue, which needs more empirical analysis to discover whether there is a tendency to prefer giving this particular role to males. Of the limited literature covering this topic, there is – in some quarters – a propensity to assume that men are more effective at maintaining collaboration strategies than women, but empirical testing does not reveal this to be the case (Bozeman & Gaughan, 2011). The topic is clearly debatable, however, as Rhoten et al summarise a body of literature on gender and research with: “Although essentialist neurobiological explanations about male and female thinking and learning styles are highly controversial, scholars of feminist science studies have long theorized that women can know the world in ways not available to men because they are less bound to the norms of science” (Rhoten & Pfirman, 2007: 59). Rhoten et al’s research drew on a survey carried out in UK higher education institutes in 1999, which identified that, “in addition to spending more time on interdisciplinary research relative to men, female respondents also reported drawing from a slightly broader range of fields than their male colleagues” (ibid, p. 62). These authors show initial results of survey data that reveal that women are more likely to carry out research that adheres to four key principles of MDA research: cross-fertilisation, team-collaboration, field-creation and problem orientation.

From the base definitions of MDAs, it is clear that each of these different approaches to research have advantages and drawbacks, and all are contested. However, the impacts of different choices in structuring research programmes, projects, and activities are not easily ascertained. Many variables can influence the way in which benefits can outweigh the costs of collaboration between disciplines in research projects and programmes.

Many authors highlight the time-consuming nature of interdisciplinarity, and yet bemoan the weakness of a standard multidisciplinary (sometimes called cross-disciplinary) approaches:

... someone is left to do the addition. If this happens during the compilation of a single summary report, those preparing it will inevitably do so from their own perspective or that of the commissioning body. If, on the other hand, the contribution of each discipline is supplied alongside that of the others with no attempt at synthesis, as in some edited collections, it is left to the individual reader to make what connections they will. In some settings, funding bodies take this approach when they commission a range of specialists from different disciplines with no or little co-ordination between them. Doubts have been raised over whether this is the best way to address complex problems (Jolly & Kavanagh, 2009: 710).

A key attribute of successful MDA research is thus the way such research is interpreted by individual researchers. Therefore, one of the most important building blocks for successful application of MDAs is the training programmes available to the next generation of researchers. We therefore need to address the way MDAs are used in teaching curricula (Mackinnon, Hine, & Barnard, 2013; Taylor, 2009).

The literature mentioned in Section B.3.2 above has shown us that there is a certain value in MDA-driven research. Yet more literature addresses (rather lamentingly) one of the major challenges for practitioners of MDAs: how their research is positioned in established frameworks. This relates not only to the spaces in which they can exercise their activities, such as publication outlets and conferences, but also concerns the evaluation of their research outputs (Paglieri, 2010). As Shapiro describes, the job of an MDA researcher can sometimes be a lonely one:

Genuine interdisciplinary research is nothing like a competitive race. It is much more like a solitary exploratory hike through an uncharted landscape. There are no community elders to give guidance, to define and rank the important research goals, or to write recommendation letters to their intellectual offspring. There are no peers to compete with or use as reviewers; and there are no community-specific journals or conferences (Shapiro, 2014: 2).

B.4.2 Collaborative exercises in research

Literature covered:

- Bruce, A. et al., 2004. Interdisciplinary Integration in Europe: The Case of the Fifth Framework Programme. *Futures*, 36(4), pp.457–470.
- Camarinha-Matos, L. M., & Afsarmanesh, H. 2005. Collaborative networks: a new scientific discipline. *Journal of Intelligent Manufacturing*, 16(4-5), pp. 439–452.
- Castán Broto, V., Gislason, M. & Ehlers, M.-H., 2009. Practising interdisciplinarity in the interplay between disciplines: experiences of established researchers. *Environmental Science & Policy*, 12(7), pp.922–933.
- Choi, B.C.K. & Pak, A.W.P., 2007. Multidisciplinarity, interdisciplinarity, and transdisciplinarity in health research, services, education and policy: 2. Promotors, barriers, and strategies of enhancement. *Clinical & Investigative Medicine*, 30(6), pp.E224–E232.

- Crane, D., 1971. Transnational networks in basic science. *International Organization*, 25(3), pp.585–601.
- Dutton, W., Carusi, A. & Peltu, M., 2006. Fostering Multidisciplinary Engagement: Communication Challenges for Social Research on Emerging Digital Technologies 1. *Prometheus*, 24(2), pp.129–149.
- Eigenbrode, S. D., O'Rourke, M., Wulfhorst, J. D., Althoff, D. M., Goldberg, C. S., Merrill, K., et al. 2007. Employing Philosophical Dialogue in Collaborative Science. *BioScience*, 57(1), pp.55-64.
- Healy, S. 1999. Extended peer communities and the ascendance of post-normal politics. *Futures*, 31(7), pp. 655–669.
- Jolly, L. & Kavanagh, L., 2009. Working out and working in critical interdisciplinarity. *Australasian Association for Engineering ...*

Whereas the authors mentioned in the previous section all deal with the role of individual researchers, a body of literature described in this section examines the construction of the research teams who carry out projects (Bruce et al., 2004; Castán Broto et al., 2009; Dutton et al., 2006; Jolly & Kavanagh, 2009). Here, several variables seem to play important roles. These are identified as the following, broadly split between **human factors** and **platforms for interaction**. Concerning human interaction, Choi and Pak ask: has a shared vision for the project been developed, what are the roles of team leaders, project managers and individual researchers? Concerning platforms for interaction, they ask: are the teams physically present in the same space, what software/technology do they use to interact, what are the institutional incentives for executing an MDA? (Choi & Pak, 2007).

Another important body of literature examines the concept of ‘team science,’ which looks at how researchers can work together at a distance (see for example (“Can Principles of Effective Team Science Promote More Robust and Reproducible Research?,” 2014)). It builds on literature from Diane Crane concerning the ‘invisible college’ of academic researchers (Crane, 1971). ‘Collaborative science’, another term that is in usage, tries to bring together different disciplines into (predominantly health-related) research that solves real world problems. As an umbrella for a range of multidisciplinary activities, Eigenbrode et al have used the term to encapsulate what they see as the major challenge driving research that is rooted in the biological sciences (Eigenbrode et al., 2007). They developed a ‘toolkit’ for philosophical dialogue between different disciplines, which is represented in Figure 1.

Eigenbrode et al’s article addresses the deeper philosophical considerations for researchers who are engaged in trying to find solutions to the wicked problems facing human beings. Whilst they focus on public health as their key area, they elucidate several key points that are of relevance for all cross-disciplinary endeavours. Notably, they highlight the tensions between reductionist and holistic approaches to science, the challenges of how the world is perceived by different scientists, and how different researchers derive motivation from the societal context of their research. In essence, although not explicitly stated, we can drawn from their article that philosophical divides that exist between researchers are not drawn across disciplinary lines, but rather more fundamental philosophical lines.

A more ‘practical’ article concerning collaborative networks, published in 2005 in the *Journal of Intelligent Manufacturing* highlights the importance of ICT in helping develop new models of interaction for researchers. It also tries to claim that collaborative

networks breed new 'disciplines', and offers a cursive review of research projects carried out in the EU's 4th, 5th and (some) 6th Framework Programmes, and their contribution to the science of collaborative networks. Their conclusion is that the efforts of creating a new 'discipline' in the field of collaboration networks have been fragmented by diverse efforts (Camarinha-Matos & Afsarmanesh, 2005).

Post-normal science, which is a popular conceptual tool in policy-related scientific circles, provides a method to engage in scientific research with a broader circle of individuals and data sets that are not based on traditional scientific methods. It is postulated that this approach may help engage scientific methods in areas of uncertainty. It is a radically different approach to scientific collaboration, that is in its infancy as a model, but has been discussed principally in terms of climate change for the moment. The authors of the seminal text on the model claim that it may lead ultimately to "the democratization of science" (Funtowicz & Ravetz, 1993). See, further, Healy's treatment of the notion of extended peer communities. This examination takes one of the fundamental precepts of the post-normal science argument. It appears to show that some of the ideas driving post-normal science are useful for policymaking, but perhaps less useful for scientific research *per se* (Healy, 1999).

Principal philosophical domain (entry point)/specific philosophical issues	Core question	Probing questions
<i>Epistemology</i> Motivation	Is applied research or basic research more important to you as a researcher?	<p>Is basic research inherently disciplinary research, or can cross-disciplinary research address basic research questions?</p> <p>How do basic and applied research relate to each other in the traditions of your discipline and in the current team project?</p> <p>Should your collaborative research project emphasize applied over basic research?</p> <p>Is there a role for advocacy in research?</p>
Methodology	In your typical disciplinary research, what methods do you use, and which are most appropriate for your collaborative study (e.g., quantitative, qualitative, experimental, case study, observational, modeling)?	<p>What kinds of data constitute scientific evidence?</p> <p>In your research, do you combine different types of research approaches?</p> <p>How are your methods related to those used by other members of your team?</p> <p>Is a hypothesis required for research to be considered science?</p> <p>How does the spatial or temporal scale of your research approach compare and interact with the scales of your team's research approaches?</p>
Confirmation	What type and amount of evidence are required for knowledge in your work?	<p>What is required to ensure that measurements are valid?</p> <p>What is required to ensure that empirical data confirm a theoretical proposal?</p> <p>Is replication necessary for confirmation?</p> <p>Can unreplicated results that are confirmed by a combination of methods qualify as knowledge?</p> <p>In what ways do your research conclusions address or incorporate uncertainty?</p>
<i>Metaphysics</i> Objectivity	Must scientific research be objective to be legitimate?	<p>In what way or ways is your research objective?</p> <p>Can one integrate values into research and still remain objective?</p> <p>Do you think it is valid to use one's personal perspective to frame a research question or hypothesis?</p> <p>Can subjective research be scientific?</p>
Values	Is value-neutral scientific research possible?	<p>If it is possible to conduct scientific research without values, how is that accomplished?</p> <p>Do you consider questions about when hypotheses count as knowledge to be value questions?</p> <p>If you regard values as an ineliminable part of scientific research, how can they be managed to avoid biasing research results and interpretations?</p> <p>Does the introduction of values into the research process amount to advocacy?</p>
Reductionism and emergence	Can the world under investigation be fully reduced to individual, independent elements for study?	<p>Are there emergent properties of the system or subject of study, or is it reducible?</p> <p>Is the context in which a subject is investigated important (i.e., is the subject of study part of a larger system that should be considered)?</p> <p>Are multiple-scale (spatial, temporal) interactions important? To what degree can and should these be addressed?</p>

Figure 1 Toolbox for philosophical dialogue, consisting of a set of questions designed to draw out collaborating scientists' views on philosophical aspects of research (Source: Eigenbrode et al. 2007).

B.5 Literature review bibliography

- Alvargonzález, D. (2011). Multidisciplinarity, Interdisciplinarity, Transdisciplinarity, and the Sciences. *International Studies in the Philosophy of Science*, 25(4), 387–403. doi:10.1080/02698595.2011.623366
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- Eddy, S. R. (2005). “Antedisciplinary” Science. *PLoS Computational Biology*, 1(1), e6. doi:10.1371/journal.pcbi.0010006
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Annex C: survey analysis

C.1 Summary

As part of the background research to this study, the contractors launched an online survey on multiple disciplinarity in European ICT research projects (bit.ly/md_study). The empirical focus of this study was on ICTs and privacy. In first instance, after an initial mapping exercise which identified projects, participants and their disciplines, coordinators of FP7 research projects that consider 'privacy' or 'data protection' as a theme/topic were invited to participate in the survey. In second instance, the survey was further distributed using the contractors' social networks. The survey aimed to gather expert input on four issues:

- Experiences in FP7 / CIP (and potentially other) projects, concerning the framing question of the research;

- Experiences in addressing that question in collaboration with other disciplines (the dynamics of the disciplinary approach);

- The conditions under which multiple disciplinary research was executed; and

- The respondent's perception on what worked and what didn't in terms of the situational context in which multiple disciplines were working together.

The questions were in part inspired by (Castán Broto et al., 2009) and (Bruce et al., 2004). Despite extensive outreach by the contractors, the survey only led to thirteen completed responses. An early analysis (ten responses) was compiled and distributed to all non-respondents, with the invitation to review findings and provide additional comments or feedback. Three additional responses were forthcoming after this message.

Section C.1 provides a summary of the survey results. Section C.2 elaborates on the results. A separate annex to this report (Annex D) details a complementary and in-depth case analysis of five FP7 / CIP research projects.

Disciplinary constellation of projects

In literature we identified four constellations for multiple disciplinary projects.

69% of respondents indicate that there is one dominant discipline in their projects. Other disciplines make either minor or major contributions to the project activities. **31% of respondents however deem that there is no single discipline dominant in their projects.** Researchers work beyond the boundaries of their disciplines.

Factors facilitating or hampering collaboration between disciplines in projects

Respondents identify **project leadership as a key factor facilitating or hampering multiple disciplinary projects**. 77% of respondents agree that their project leader was a good manager of collaboration between disciplines. One survey respondent states that there is a need for interdisciplinary and inspiring project coordinators in multiple disciplinary projects.

Further respondents agree that **the existence and pursuit of a single point objective fostered collaboration between disciplines**. Almost all respondents deem that the disciplines in their projects were well chosen in light of the overall objective. One survey respondent believes that the trial of artifacts brings disciplines together.

92% of respondents state that their project partners were open to input from other disciplines. 62% of respondents indicate that partners were even willing to develop new joint terminology and methodology. One survey respondent identifies experience in conducting research projects as an important factor in facilitating collaboration between researchers from different disciplines.

The majority of respondents find that **different terminologies and methods used in different disciplines made collaboration a challenge. Communication across disciplines is also time-consuming**.

Quality of collaboration and communication between project partners

All respondents consider personal meetings, e-mail, document/data-sharing, phone and video meetings important in projects. A majority of respondents state that **personal meetings, e-mail and document/data-sharing are very important**.

For some respondents, forums and wikis are important. For the majority of respondents however, they are irrelevant, not applicable or not required.

Two survey respondents deem a shared workspace important for collaboration and communication between project partners.

Input from social sciences and/or humanities disciplines in projects

There was **input from the social sciences and/or humanities disciplines in 62%** of the projects. Respondents argue that **the contribution from social sciences and/or humanities was crucial to the development of the project**. One respondent specifies that it drove forward the project in terms of model building, methodology and analysis. Another respondent explains that the input from social sciences and/or humanities is patchy and variable between project activities.

Situations where involvement of and collaboration between multiple disciplines added value

In literature we identified seven situations where involvement of and collaboration between multiple disciplines might add value.

Respondents consider all proposed situations useful and important. There is near consensus that **multiple disciplines add value in situations where there is a**

need to make a better link between theory and practice, provide different perspectives on a problem, generate comprehensive research approaches, generate policy-relevant insights and foster creativity and out-of-the-box thinking.

A minority of respondents believe that **MDAs are not practical** for resolving real world and complex problems. One honest but critical respondent shares that the project in which (s)he was involved, was badly designed overall and that there weren't enough social scientists involved.

On a more positive note, **77% of the respondents would have designed a multiple disciplinary project even if the call text did not require it.**

C.2 Survey data set

Profile of respondents (questions 1-6)

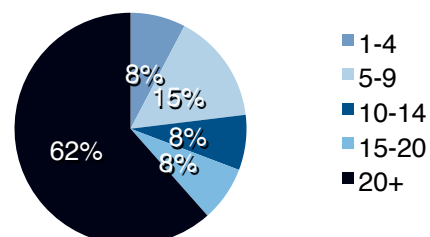
The survey respondents have high expertise.

- **62% of respondents have 20+ years of professional experience.**
- Four respondents have a disciplinary background in social sciences and/or humanities, seven have a disciplinary background in science & technology, two have a double disciplinary background in social sciences and science & technology.
- **62% of respondents have training or extensive experience in more than one discipline.**
- Respondents work in a variety of institutions: five are employed in universities, four work in research institutes, two are employed in private companies and two work in SMEs.
- Five respondents are involved in projects identified by the team (ABC4Trust, CUMULUS, EEXCESS, EINS and LINKED2SAFETY), eight are involved in other ICT or SEC projects (ADVISE, ATTPS, Chronious, Citadel on the Move, eGovPoliNet and iURBAN).
- 54% of respondents are coordinators of projects.

1. How many years of professional experience do you have?

- A. 15-20
- B. 20+
- C. 5-9
- D. 20+
- E. 20+
- F. 20+
- G. 20+
- H. 20+
- I. 5-9
- J. 20+

Years of professional experience

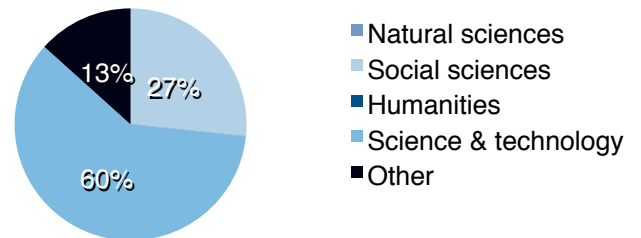


- K. 20+
- L. 1-4
- M. 10-14

2. What is your specific disciplinary background?

- A. Social sciences
- B. Other: political sciences
- C. Science & technology: ICT
- D. Other: law
- E. Science & technology: ICT
- F. Social sciences AND science & technology
- G. Social sciences: economics AND science & technology: computer science
- H. Science & technology: microelectronics, ICT
- I. Science & technology: mathematics, IT
- J. Science & technology: industrial design & engineering
- K. Science & technology: ICT in business and administration, system and architectural approaches
- L. Social sciences: communication sciences
- M. Science & technology: information systems

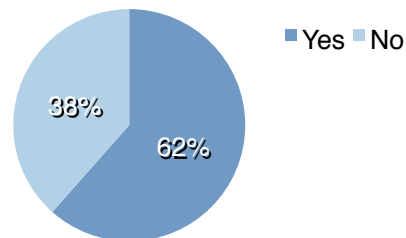
Disciplinary background



3. Have you had training or extensive (more than 4 years) experience in more than one discipline?

- A. Yes: human factors engineering *and* law
- B. No
- C. No
- D. Yes
- E. Yes: electronics *and* IT *and* Telemedicine
- F. Yes
- G. Yes: computer science *and* economics
- H. Yes: microelectronics *and* ICT *and* business models *and* energy
- I. No
- J. Yes: innovation management
- K. Yes: IS strategic management *and* project management *and* risk management *and* organizational design *and* business (administrative) processes reengineering, etc.
- L. No
- M. No

Training/experience in more than one discipline

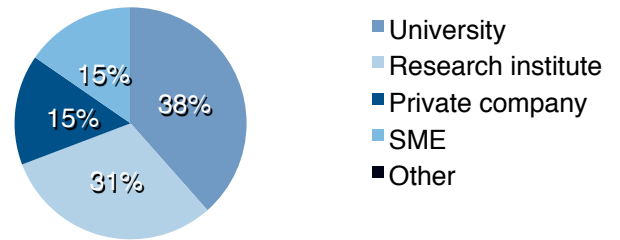


4. In which type of institution do you work?

- A. University

- B. Private company
- C. Research institute
- D. University
- E. Private company
- F. Research institute
- G. University
- H. SME
- I. Research institute
- J. SME
- K. University
- L. Research institute
- M. University

Type of institution



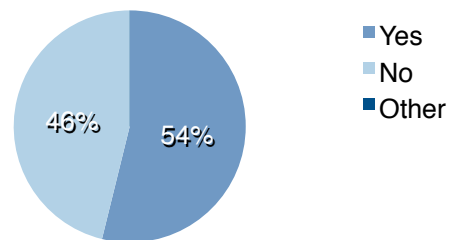
5. Please identify the project in which you consider yourself to be most involved.

- A. Other: rather not say
- B. Other: ADVISE
- C. Other: ADVISE
- D. EINS
- E. Other: Chronious
- F. CUMULUS
- G. ABC4Trust
- H. Other: iURBAN
- I. EEXCESS
- J. Other: ATTPS
- K. Other: eGovPoliNet
- L. Other: Citadel on the Move
- M. LINKED2SAFETY

6. Were you a coordinator of this project?

- A. No
- B. Yes
- C. No
- D. No
- E. Yes
- F. Yes
- G. Yes
- H. Yes
- I. Yes
- J. Yes
- K. No
- L. No
- M. No

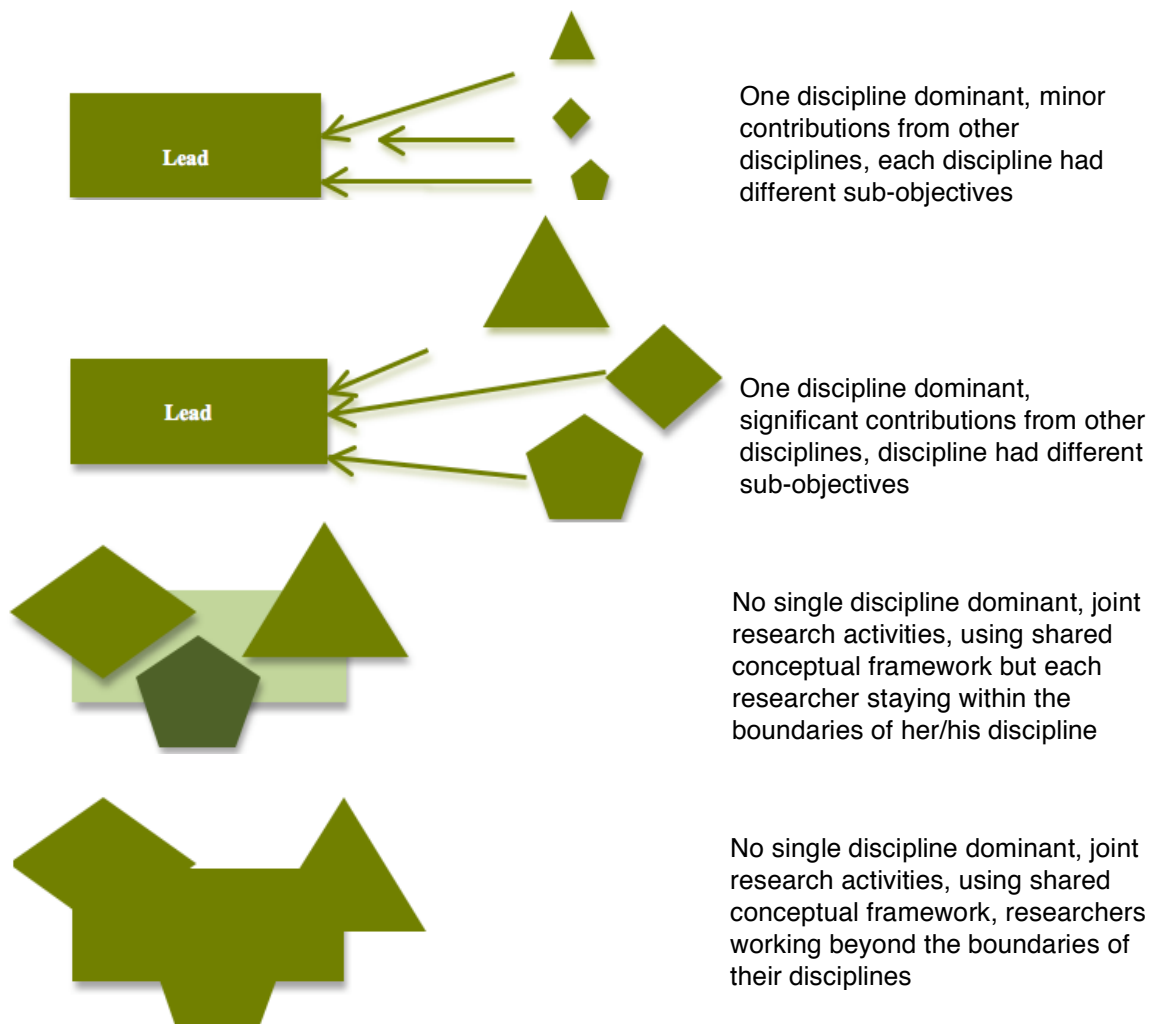
Coordinator of project



Disciplinary nature of projects (questions 7-9)

In literature we have identified four constellations for multiple disciplinary projects (see figures below).

- **69% of respondents indicate that there is one dominant discipline in their projects.** Other disciplines make either minor or major contributions to the project activities. **31% of respondents however deem that there is no single discipline dominant in their projects.** Researchers work beyond the boundaries of their disciplines.
- Further some respondents had project partners with teams of composed of researchers from different disciplines. Others had project partners with teams of researchers from one discipline.



7. Please indicate the discipline of all project partners.

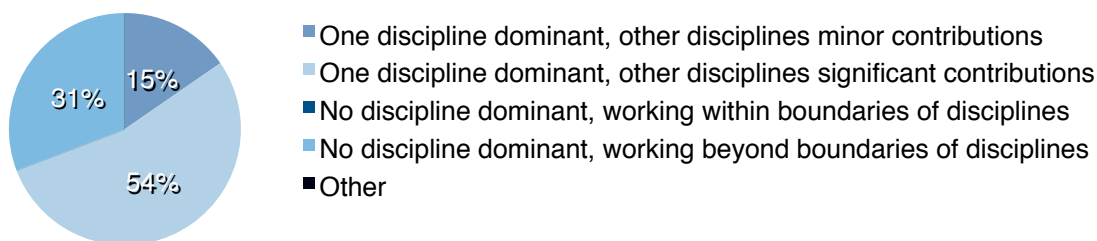
- C. Coordinator: ICT
Partner 1: ICT
Partner 2: humanities

- D. Coordinator: computer science
33 partners: 20+ from computer science
- H. Coordinator: ICT
Partners 1-2: ICT
Partner 3: business models
Partners 4-5: energy
Partners 6-7: urban planning
Partner 8: psychology
- J. Coordinator: innovation management
Partners 1-8: science & technology
- K. Coordinator: eGovernance
Partner 1: Policy modeling
Partner 2: ICT in public services
Partner 3: eService quality management
Partner 4: Administrative processes modeling, analysis and optimization
Partner 5: Policy modeling

8. Which partner constellation best describes the project activities?

- A. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives
- B. No single discipline dominant, joint research activities, using shared conceptual framework, researchers working beyond the boundaries of their disciplines
- C. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives
- D. No single discipline dominant, joint research activities, using shared conceptual framework, researchers working beyond the boundaries of their disciplines
- E. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives
- F. One discipline dominant, minor contributions from other disciplines, each discipline had different sub-objectives
- G. No single discipline dominant, joint research activities, using shared conceptual framework, researchers working beyond the boundaries of their disciplines
- H. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives
- I. No single discipline dominant, joint research activities, using shared conceptual framework, researchers working beyond the boundaries of their disciplines
- J. One discipline dominant, minor contributions from other disciplines, each discipline had different sub-objectives
- K. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives
- L. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives
- M. One discipline dominant, significant contributions from other disciplines, discipline had different sub-objectives

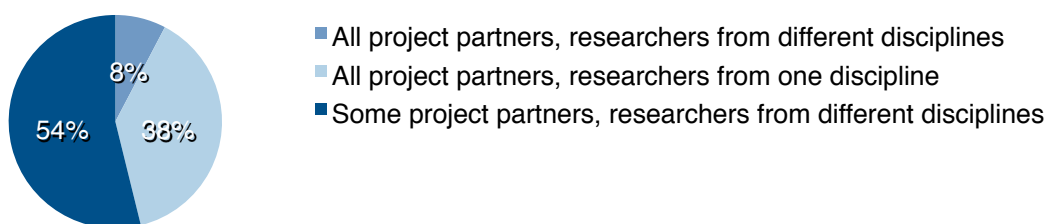
Partner constellation



9. How were the different project partners composed?

- A. Some individual project partners were composed of researchers from different disciplines
- B. All individual project partners were composed of researchers from one particular discipline
- C. Some individual project partners were composed of researchers from different disciplines
- D. Some individual project partners were composed of researchers from different disciplines
- E. Some individual project partners were composed of researchers from different disciplines
- F. All individual project partners were composed of researchers from one particular discipline
- G. Some individual project partners were composed of researchers from different disciplines
- H. All individual project partners were composed of researchers from one particular discipline
- I. Some individual project partners were composed of researchers from different disciplines
- J. All individual project partners were composed of researchers from one particular discipline
- K. All individual project partners were composed of researchers from different disciplines
- L. Some individual project partners were composed of researchers from different disciplines
- M. All individual partners were composed of researchers from one particular discipline

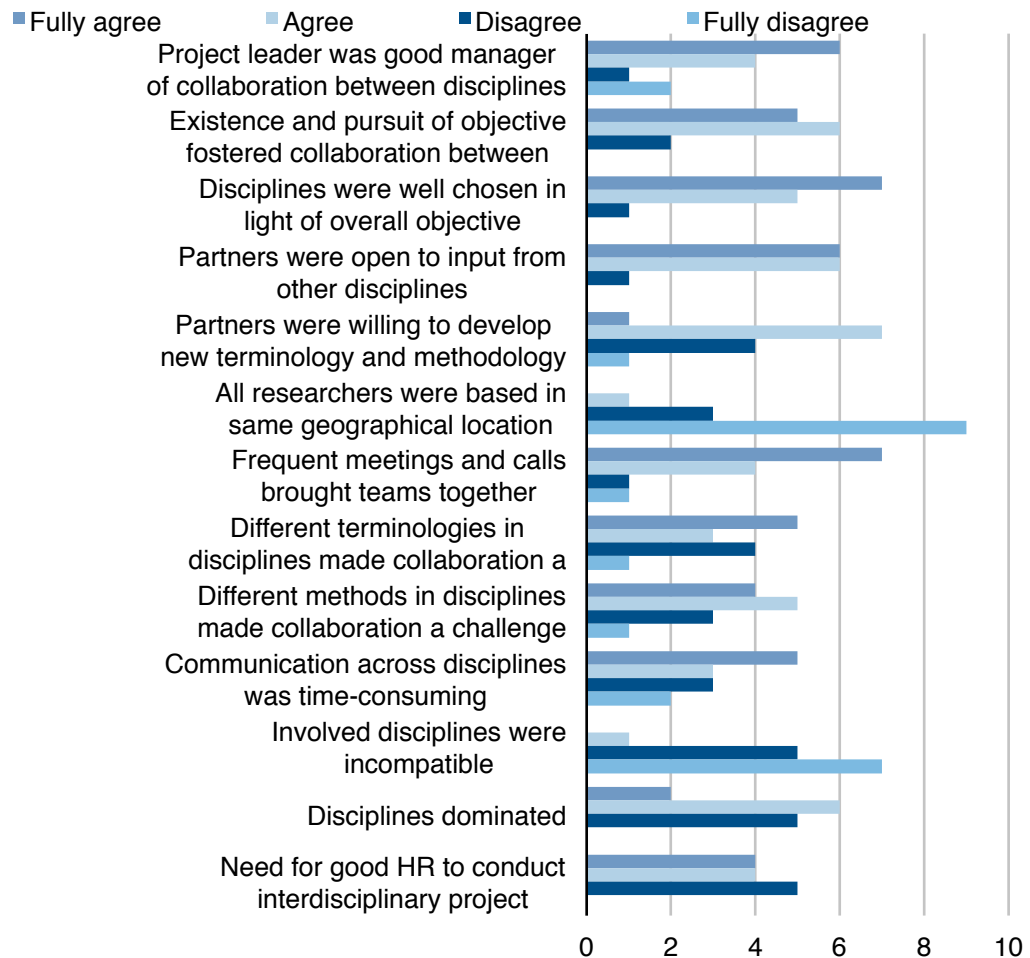
Partner composition



Factors facilitating or hampering collaboration between disciplines in projects (question 10)

- Respondents identify **project leadership as a key factor facilitating or hampering multiple disciplinary projects**. 77% of respondents agree that their project leader was a good manager of collaboration between disciplines. One survey respondent states that there is a need for interdisciplinary and inspiring project coordinators in multiple disciplinary projects.
- 62% of respondents also indicate that there is a need for a good human resources team to conduct interdisciplinary projects.
- Further respondents agree that **the existence and pursuit of a single point objective fostered collaboration between disciplines**. Almost all respondents deem that the disciplines in their projects were well chosen in light of the overall objective. One survey respondent believes that the trial of artifacts brings disciplines together.
- **92% of respondents state that their project partners were open to input from other disciplines. 62% respondents indicate that partners were even willing to develop new joint terminology and methodology**. One survey respondent identifies experience in conducting research projects as an important factor in facilitating collaboration between researchers from different disciplines.
- Lastly in terms of facilitating collaboration respondents indicate that frequent meetings and calls brought all project teams together.
- The majority of respondents find that **different terminologies and methods used in different disciplines made collaboration a challenge. Communication across disciplines is also time-consuming**.
- Confirming their answers to other survey questions, 62% of respondents deem that one discipline dominated over others in their projects. Nonetheless the involved disciplines were compatible. One interview respondent deems the involved disciplines incompatible.

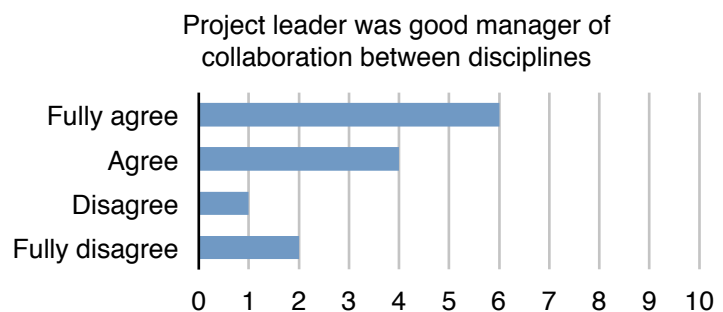
Summary chart: how important were the following factors in facilitating or hampering the collaboration between researchers from different disciplines in the project?



10. How important were the following factors in facilitating or hampering the collaboration between researchers from different disciplines in the project?

The project leader was a good manager of the collaboration between different disciplines

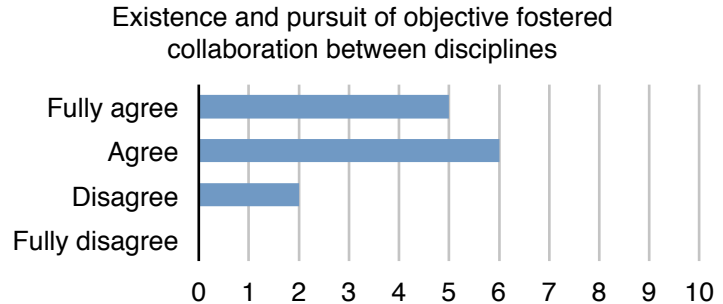
- A. Fully disagree
- B. Agree
- C. Fully agree
- D. Fully disagree
- E. Agree
- F. Fully agree
- G. Fully agree
- H. Fully agree
- I. Agree
- J. Disagree
- K. Fully agree
- L. Agree



M. Fully agree

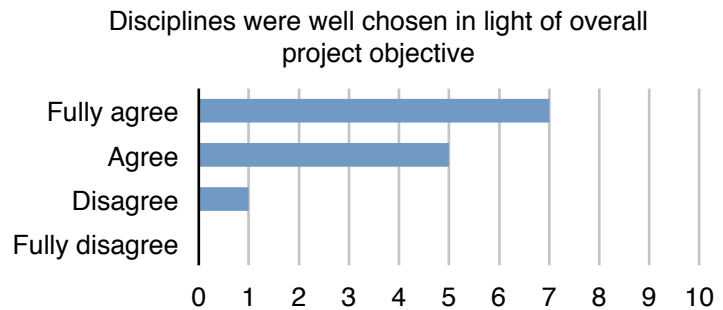
The existence and pursuit of a single point objective fostered collaboration between different disciplines

- A. Agree
- B. Fully agree
- C. Agree
- D. Disagree
- E. Agree
- F. Agree
- G. Fully agree
- H. Fully agree
- I. Agree
- J. Disagree
- K. Fully agree
- L. Agree
- M. Fully agree



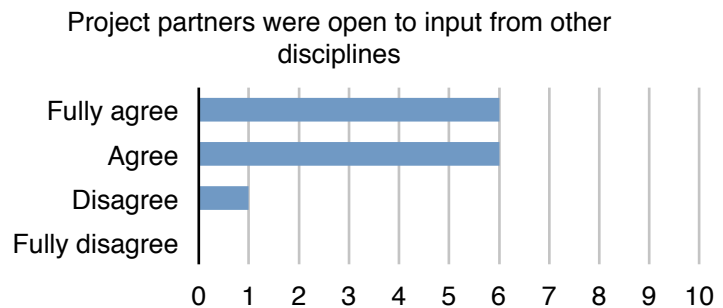
The disciplines were well chosen in light of the overall project objective

- A. Agree
- B. Agree
- C. Fully agree
- D. Agree
- E. Agree
- F. Disagree
- G. Fully agree
- H. Fully agree
- I. Fully agree
- J. Fully agree
- K. Agree
- L. Fully agree
- M. Fully agree



Project partners were open to input from other disciplines

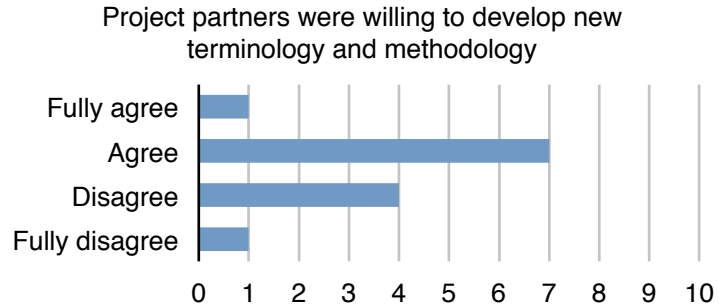
- A. Disagree
- B. Fully agree
- C. Agree
- D. Agree
- E. Agree
- F. Agree
- G. Fully agree
- H. Fully agree
- I. Fully agree
- J. Agree
- K. Fully agree



- L. Fully agree
- M. Agree

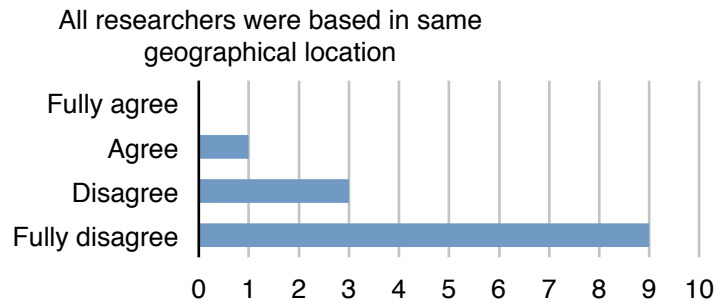
Project partners were willing to develop new joint terminology and methodology

- A. Disagree
- B. Agree
- C. Agree
- D. Disagree
- E. Agree
- F. Agree
- G. Fully agree
- H. Agree
- I. Agree
- J. Disagree
- K. Disagree
- L. Agree
- M. Fully disagree



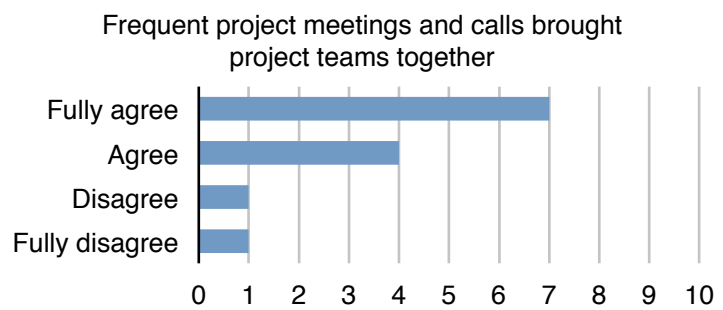
All researchers were based in the same geographical location

- A. Disagree
- B. Fully disagree
- C. Fully disagree
- D. Fully disagree
- E. Fully disagree
- F. Fully disagree
- G. Fully disagree
- H. Disagree
- I. Disagree
- J. Fully disagree
- K. Fully disagree
- L. Fully disagree
- M. Agree



Frequent project meetings and calls brought all project teams together

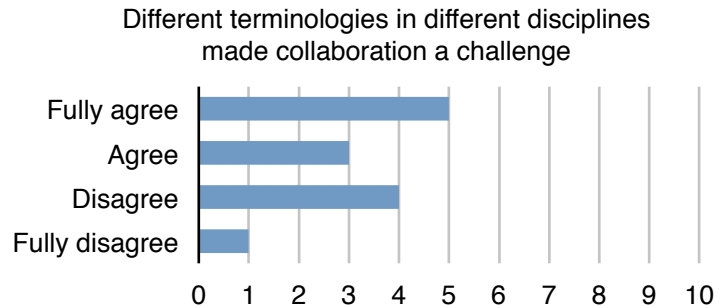
- A. Disagree
- B. Fully agree
- C. Agree
- D. Fully disagree
- E. Agree
- F. Fully agree
- G. Fully agree
- H. Fully agree
- I. Agree
- J. Agree
- K. Fully agree



- L. Fully agree
- M. Fully agree

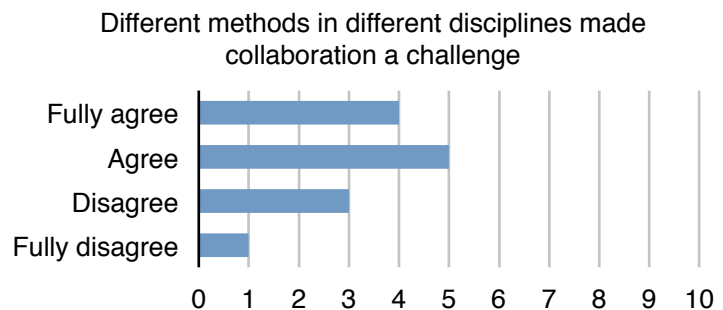
Different terminologies used in different disciplines made collaboration a challenge

- A. Agree
- B. Fully agree
- C. Fully agree
- D. Fully agree
- E. Agree
- F. Disagree
- G. Disagree
- H. Fully agree
- I. Disagree
- J. Fully disagree
- K. Disagree
- L. Agree
- M. Fully agree



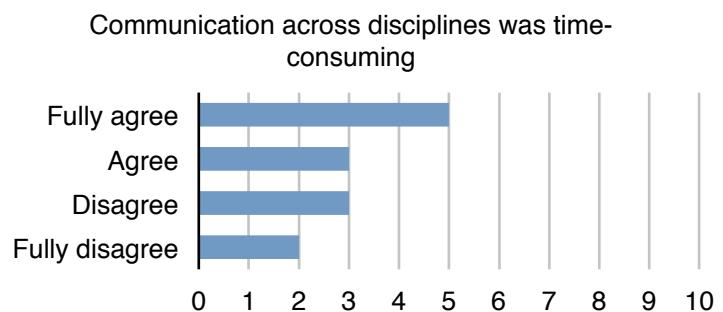
Different methods used in different disciplines made collaboration a challenge

- A. Agree
- B. Fully agree
- C. Agree
- D. Fully agree
- E. Agree
- F. Fully disagree
- G. Disagree
- H. Agree
- I. Disagree
- J. Disagree
- K. Fully agree
- L. Fully agree
- M. Agree



Communication across disciplines was time-consuming

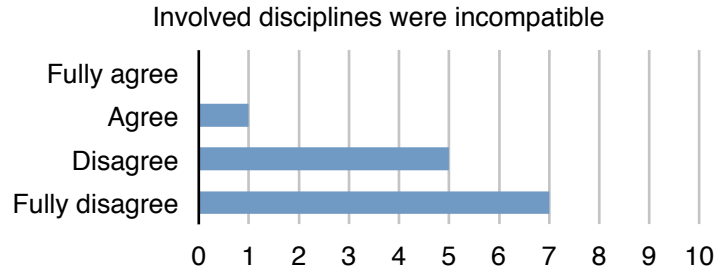
- A. Agree
- B. Fully agree
- C. Fully agree
- D. Fully agree
- E. Disagree
- F. Fully disagree
- G. Agree
- H. Fully agree
- I. Fully disagree
- J. Disagree
- K. Agree



- L. Disagree
- M. Fully agree

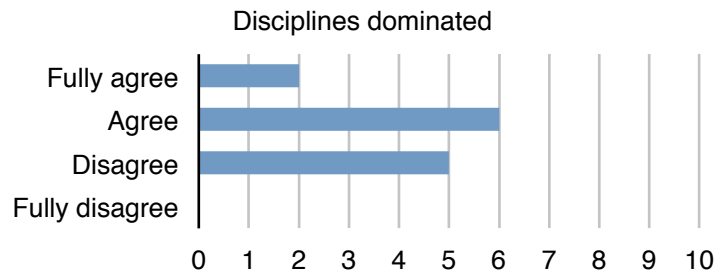
The involved disciplines were incompatible

- A. Agree
- B. Disagree
- C. Disagree
- D. Disagree
- E. Disagree
- F. Fully disagree
- G. Fully disagree
- H. Disagree
- I. Fully disagree
- J. Fully disagree
- K. Fully disagree
- L. Fully disagree
- M. Fully disagree



Disciplines dominated the others

- A. Agree
- B. Disagree
- C. Disagree
- D. Fully agree
- E. Agree
- F. Fully agree
- G. Disagree
- H. Agree
- I. Disagree
- J. Agree
- K. Disagree
- L. Agree
- M. Agree



Need for a good human resources team to conduct an interdisciplinary project

- A. Agree
- B. Fully agree
- C. Disagree
- D. Agree
- E. Fully agree
- F. Fully agree
- G. Disagree
- H. Fully agree
- I. Agree
- J. Disagree
- K. Agree



- L. Disagree
- M. Disagree

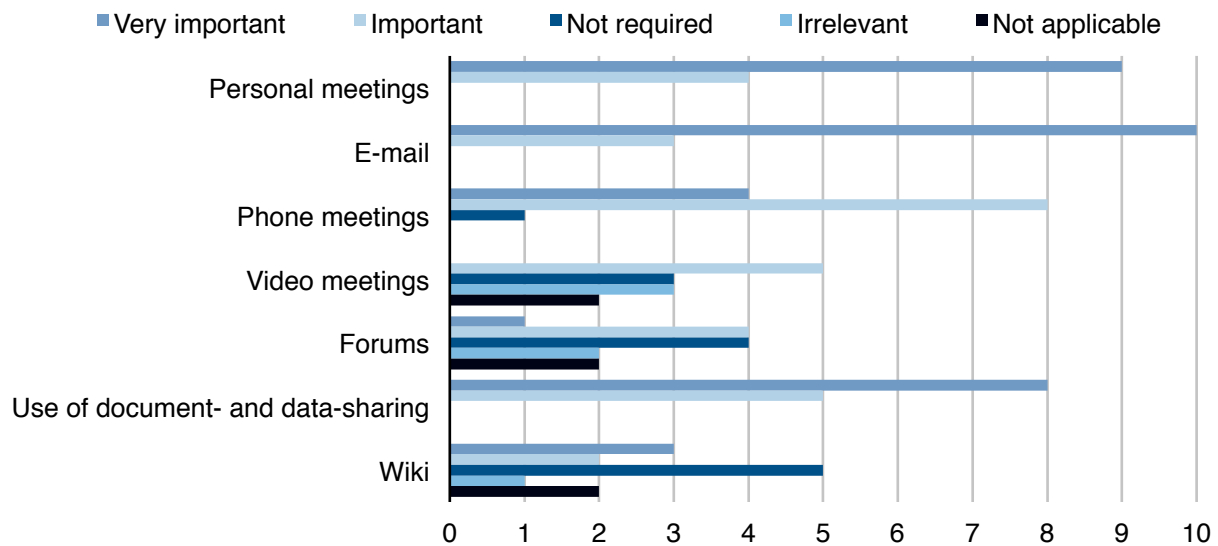
Please specify other factors in facilitating collaboration between researchers from different disciplines in the project

- A. Extremely weak leadership was a problem for us
- D. Need for inter-disciplinary and inspiring coordinator and flexible PI
- G. A trial trying out the artifacts developed in the project has as the useful side effect that people of different disciplines have a common goal
- H. Experience in conducting research projects

Quality of collaboration and communication between project partners (question 11)

- All respondents consider personal meetings, e-mail, document/data-sharing, phone and video meetings important in projects. A majority of respondents state that **personal meetings, e-mail and document/data-sharing are very important.**
- For some respondents, forums and wikis are important. For the majority of respondents however, they are irrelevant, not applicable or not required.
- Two survey respondents deem a shared workspace important for collaboration and communication between project partners.

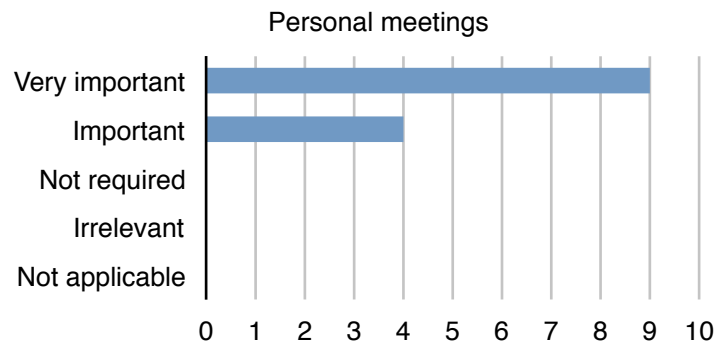
Summary chart: how would you assess the quality of the collaboration and communication between the different project partners?



11. How would you assess the quality of the collaboration and communication between the different project partners?

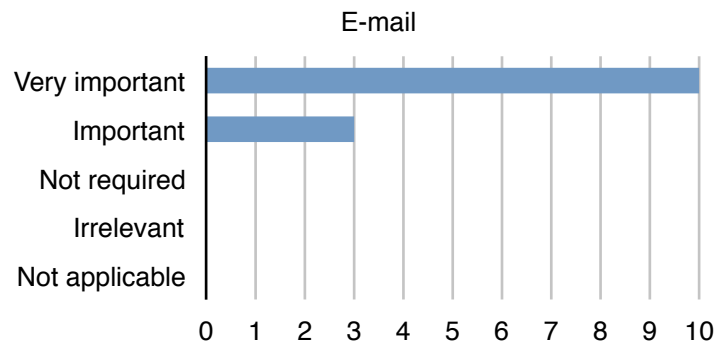
Personal meetings

- A. Important
- B. Very important
- C. Very important
- D. Very important
- E. Very important
- F. Very important
- G. Important
- H. Very important
- I. Very important
- J. Important
- K. Important
- L. Very important
- M. Very important



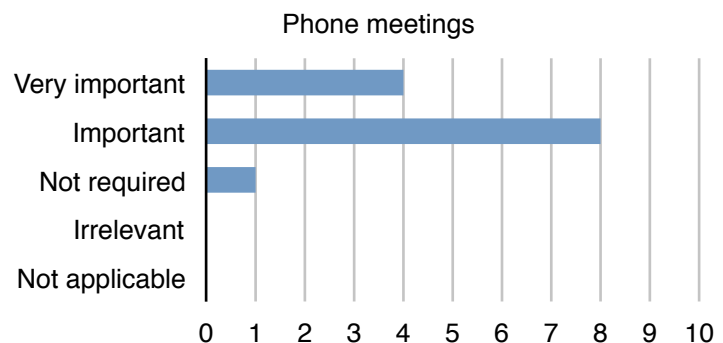
E-mail

- A. Important
- B. Very important
- C. Important
- D. Very important
- E. Very important
- F. Very important
- G. Very important
- H. Very important
- I. Very important
- J. Very important
- K. Very important
- L. Important
- M. Very important



Phone meetings

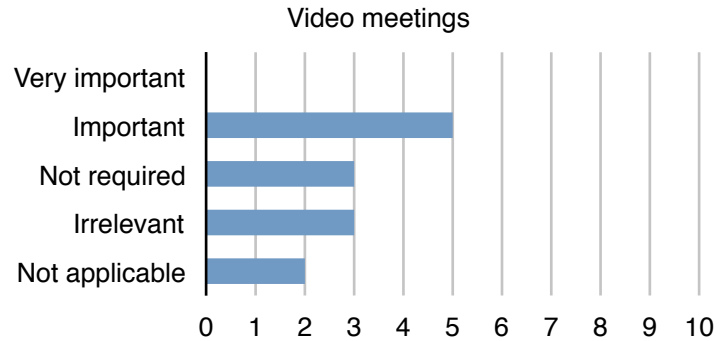
- A. Important
- B. Very important
- C. Important
- D. Very important
- E. Important
- F. Important
- G. Important
- H. Very important
- I. Important
- J. Important
- K. Not required
- L. Important



M. Very important

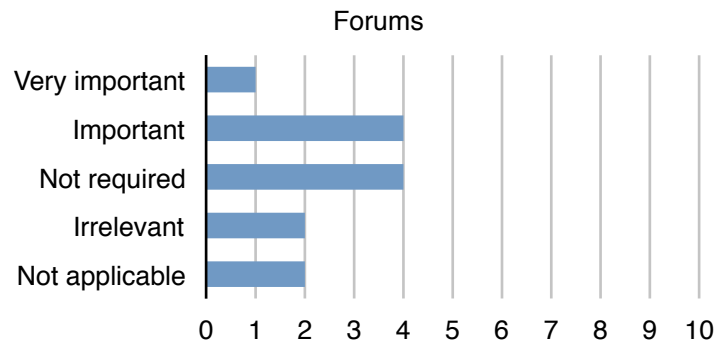
Video meetings

- A. Irrelevant
- B. Not required
- C. Not required
- D. Irrelevant
- E. Important
- F. Irrelevant
- G. Important
- H. Not required
- I. Important
- J. Important
- K. Important
- L. Not applicable
- M. Not applicable



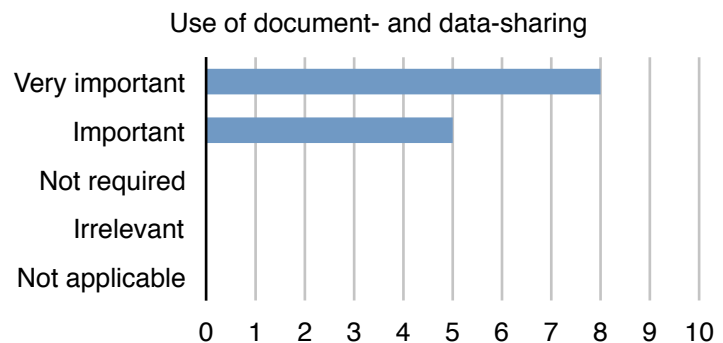
Forums

- A. Irrelevant
- B. Not required
- C. Not applicable
- D. Very important
- E. Irrelevant
- F. Important
- G. Important
- H. Not required
- I. Not required
- J. Not required
- K. Important
- L. Important
- M. Not applicable



Use of document- and data-sharing

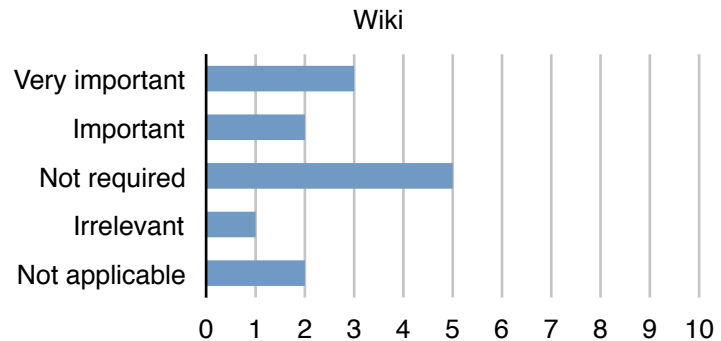
- A. Important
- B. Very important
- C. Very important
- D. Very important
- E. Important
- F. Very important
- G. Very important
- H. Important
- I. Important
- J. Important
- K. Very important
- L. Very important



M. Very important

Wiki

- A. Irrelevant
- B. Very important
- C. Very important
- D. Not required
- E. Not required
- F. Important
- G. Very important
- H. Not required
- I. Not required
- J. Not required
- K. Important
- L. Not applicable
- M. Not applicable



How many face to face meetings were held every year

A-M. 1-12 (≤ 1 per month)

Were there other means for collaboration or communication between the project partners that wasn't listed above

- H. Everything listed in the table above
- J. Shared workspace
- K. Common workspace (timetables, tasks, progress, discussions) and knowledge bank at the project website
- M. Skype conference calls

Input from social sciences and/or humanities disciplines in projects (questions 12-13)

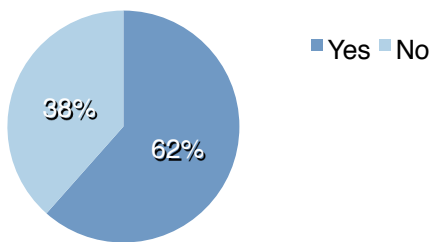
There was **input from the social sciences and/or humanities disciplines in 62%** of the projects. Respondents argue that **the contribution from social sciences and/or humanities was crucial to the development of the project**. One respondent specifies that it drove forward the project in terms of model building, methodology and analysis. Another respondent explains that the input from social sciences and/or humanities is patchy and variable between project activities.

12. Was there input from social sciences and/or humanities disciplines into the execution of your research project(s)? If yes, how would you assess this input?

- A. Yes: it totally drove it forward in terms of model building, methodology and analysis

- B. Yes: legal ethical privacy
- C. Yes: the contribution was crucial to the development of the project
- D. Yes: patchy and variable between activities
- E. No
- F. No
- G. Yes: useful
- H. Yes: it is a must for the ICT discipline
- I. No
- J. No
- K. Yes: very important. eGovernance needs to understand and predict social reactions on policy implementation
- L. Yes: living lab research
- M. No

Input from social sciences/
humanities in project



13. What were the main achievements of the research project(s), and to what extent were these due to its/their multiple disciplinarity? In what way did multiple disciplinarity add value, if at all?

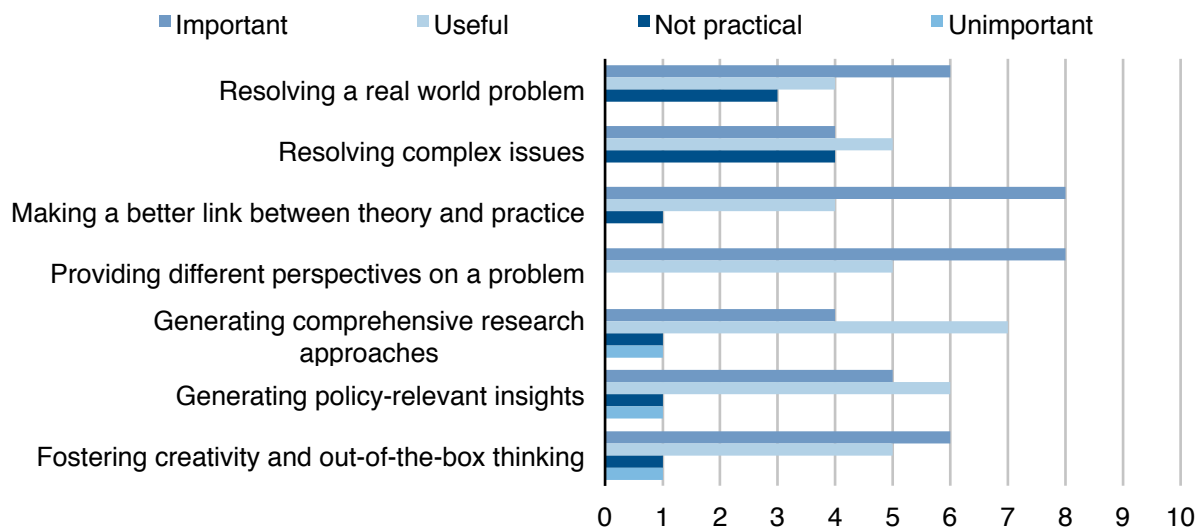
- A. Still ongoing
- B. Privacy impact assessment. Collaboration between software engineers and legal/ethical/privacy experts
- C. The project develops a search engine for surveillance video repositories. The inclusion of the humanities discipline enabled the creation of an effective privacy-protection framework
- D. Still in progress, only 60% completed
- H. The project is ongoing
- J. Architectural design, demonstrators, testbed and living lab for trustworthy ICT solutions
- K. The community consisted of researchers and practitioners from various areas. It is necessary to apply multidisciplinary approaches to solve complex problem

Situations where involvement of and collaboration between multiple disciplines added value (questions 14-16)

In the survey we identify seven situations where involvement of and collaboration between multiple discipline might add value (see list below).

- Respondents consider all proposed situations useful and important. There is near consensus that **multiple disciplines add value in situations where there is a need to make a better link between theory and practice, provide different perspectives on a problem, generate comprehensive research approaches, generate policy-relevant insights and foster creativity and out-of-the-box thinking.**
- A minority of respondents believe that **multiple disciplines are not practical** for resolving real world and complex problems. One honest but critical respondent shares that the project in which (s)he was involved, was badly designed overall and that there weren't enough social scientists involved.
- On a more positive note, **77% of respondents would have designed a multiple disciplinary project even if the call text did not require it.**

Summary chart: in which situations in your project do you think the involvement of and collaboration between multiple disciplines added value?

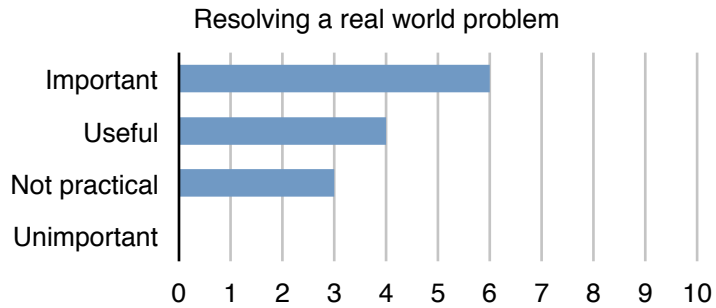


14. In which situations in your project do you think the involvement of and collaboration between multiple disciplines added value?

Resolving a real world problem

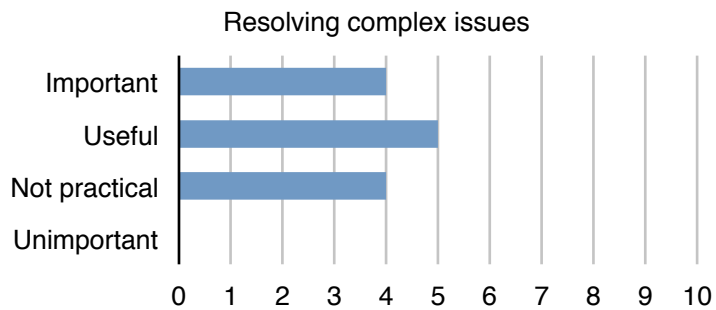
- Not practical
- Useful
- Not practical
- Useful

- E. Useful
- F. Not practical
- G. Important
- H. Important
- I. Important
- J. Useful
- K. Important
- L. Important
- M. Important



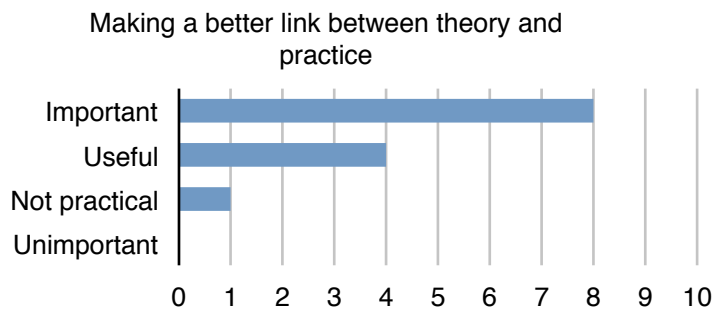
Resolving complex issues

- A. Not practical
- B. Useful
- C. Not practical
- D. Useful
- E. Important
- F. Not practical
- G. Useful
- H. Not practical
- I. Useful
- J. Important
- K. Important
- L. Important
- M. Useful



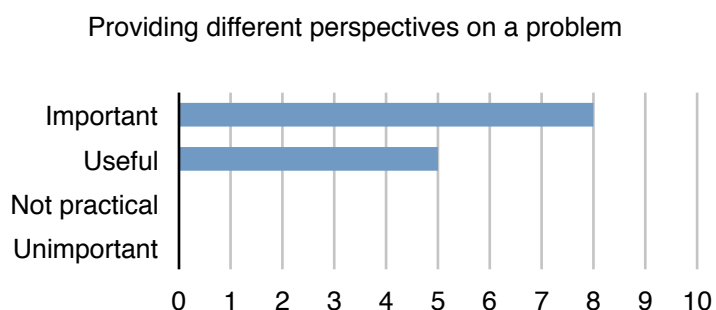
Making a better link between theory and practice

- A. Not practical
- B. Important
- C. Useful
- D. Useful
- E. Important
- F. Important
- G. Important
- H. Important
- I. Important
- J. Useful
- K. Important
- L. Useful
- M. Important



Providing different perspectives on a problem

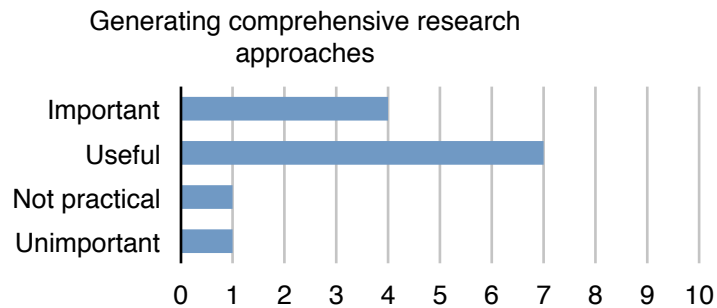
- A. Useful
- B. Important
- C. Important
- D. Useful
- E. Useful



- F. Important
- G. Important
- H. Important
- I. Useful
- J. Useful
- K. Important
- L. Important
- M. Important

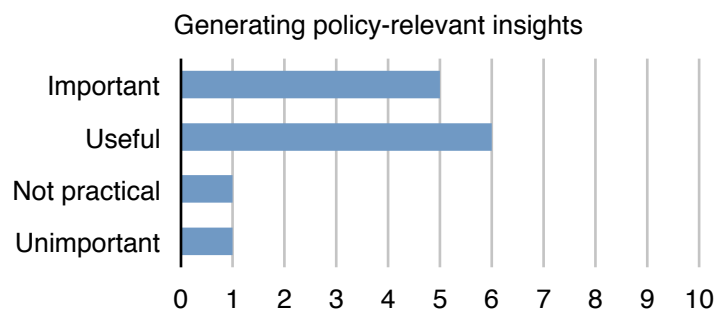
Generating comprehensive research approaches

- A. Not practical
- B. Useful
- C. Important
- D. Useful
- E. Useful
- F. Useful
- G. Useful
- H. Important
- I. Important
- J. Useful
- K. Important
- L. Useful
- M. Unimportant



Generating policy-relevant insights

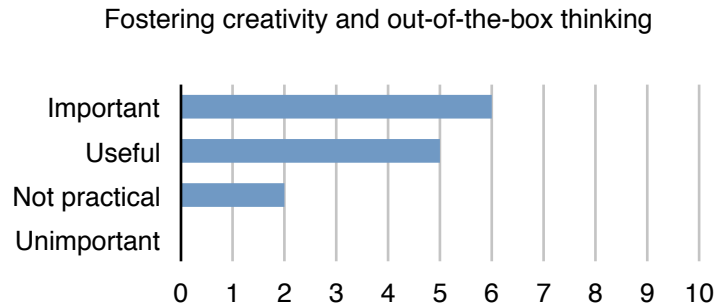
- A. Useful
- B. Important
- C. Important
- D. Important
- E. Useful
- F. Useful
- G. Important
- H. Useful
- I. Not practical
- J. Useful
- K. Important
- L. Useful
- M. Unimportant



Fostering creativity and out-of-the-box thinking

- A. Not practical
- B. Important
- C. Useful
- D. Useful
- E. Important

- F. Important
- G. Useful
- H. Important
- I. Important
- J. Useful
- K. Important
- L. Useful
- M. Not practical



Please specify other situations where the involvement of and collaboration between multiple disciplines had an added value

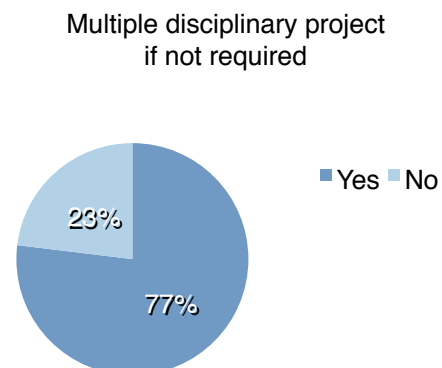
- K. Explaining and solving problems which could not be explained or solved within their native disciplines

15. In retrospect, which disciplines should have been combined in your research project?

- A. The project was badly designed overall, there weren't enough social scientists involved and there were too many free riders who were non social scientists, didn't understand what was going on, were just disruptive and were dangerously stupid.
- B. Social sciences
- D. Majority not computer science
- H. Business, sociology, ICT, energy

16. Would you have designed a multiple disciplinary project even if the call text did not require it?

- A. No
- B. Yes: social sciences could be considered
- C. Yes: if I thought that this would give significant added value
- D. Yes: already had pre-2010 but within a country/ UK-US
- E. No
- F. Yes
- G. Yes: for the reasons given in table 14
- H. Yes: if it is needed, yes
- I. Yes
- J. No
- K. Yes: just because the mono disciplinary project is unreal in the area
- L. Yes
- M. Yes: the problem usually dictates multidisciplinary



Comments or recommendations (questions 17-18)

Four survey respondents provided email addresses to be informed about the outcome of the project. They will also be contacted to inquire whether they would be willing to participate in a personal interview or the validation workshop.

17. If you have comments or recommendations concerning this research project, please specify.

- D. Deliverables-fest made project joy-less in Year 2 - hopefully will re-energise Years 3/4
- G. I am surprised that something as self-evident as multidisciplinary in a research project needs a study to explore

18. If you would like to be informed about the outcome of this project and/or willing to participate in a personal interview, please enter your email address here.

<redacted>

Annex D: Case analysis

D.1 Context

Privacy in ICT research is exemplar of multiple disciplinary approaches, because it pertains to the integration of legal and social considerations into primarily technology-driven projects. The political and social context of privacy in ICT research is one of the growth *and* questioning of surveillance (Lyon, 2007; Brown, & Marsden, 2013). A range of actors from online advertisers to public administration and law enforcement officials have interest in processing personal data — for the purposes of market share, bureaucratic efficiency and social order. Equally however, there is increased public awareness of data breaches, a need to maintain public trust and general agreement in Europe on the inherent value of the rights to private life and data protection. It is important to emphasize that from the study team's perspective, the discussion of privacy is not black or white. Indeed surveillance is inherent in society. It is a matter of defining and developing its acceptable and appropriate applications. Several authors have taken different approaches to this. We have chosen to outline the following examples, which emphasise privacy, ICTs and multiple disciplinarity.

Burgess, J.P. and Kloza, D. (2014, forthcoming). *Privacy, Data Protection and Ethical Issues in Advanced Video Surveillance Archives Search Engines for Security Applications. The Case of the ADVISE Research Project*. Brussels: ADVISE Project Report.

ADVISE (Advanced Video Surveillance archives search Engine for security applications) aims at developing automatic and smart surveillance solutions for law enforcement agencies. The project partners share a common objective to develop a prototype that promotes privacy by design. The chosen means of implementation is an extensive and tailored privacy impact assessment (PIA), taking into account privacy, data protection and ethical issues. This paper includes details on the development and first application of the PIA. Particularly interesting for this study is the feedback of project partners. It is acknowledged that working in a multiple disciplinary manner requires wo/manpower and time. Project partners appreciate the terminological openness and explanation provided — a guided approach is deemed necessary for technical partners to understand the notion of privacy impact assessment.

Hansen, M. (2012). Top 10 Mistakes in System Design from a Privacy Perspective and Privacy Protection Goals. In J. Camenisch et al. (Eds.), *Privacy and Identity Management for Life* (pp. 14-31). Heidelberg: Springer.

Marit Hansen is a computer scientist with more than fifteen years of experience at a Data Protection Authority. In this paper she provides insight into typical attitudes of system designers that cause privacy vulnerabilities. One example is approaching function creep as a feature. Hansen explains that computer scientists aim at re-using code. "Function

creep is not regarded as a bug, but as a feature” (Hansen, 2012, 20). This paper is interesting, because it demonstrates in-depth understanding of the technical, legal and social issues at hand when developing systems that promote privacy by design. Hansen calls computer scientists to strive for three privacy protection goals – unlinkability, transparency and intervenability – linking and comparing them with traditional security protection goals on the one hand and data protection principles on the other. The paper is accessible to readers from multiple disciplines, using definitions, figures and tables to illustrate and tease out interrelations.

Dutton, W., Carusi, A. & Peltu, M. (2006). Fostering Multidisciplinary Engagement: Communication Challenges for Social Research on Emerging Digital Technologies. *Prometheus: Critical Studies in Innovation*, 24(2), 129-149.

The authors of this paper report on the outcome of a joint workshop organized by the Oxford Internet Institute (OII) and Massachusetts Institute of Technology (MIT). The workshop sought to better understand “the degree to which social scientists can contribute theoretical and practical insights of value to designers, engineers, business managers, government policy makers, civil society and others with a stake in using, developing, managing and regulating the Internet and related ICTs” (Dutton et al., 2006, 130). Developing common points of reference is deemed particularly important. The authors make several references to privacy in the paper. They highlight that there can be competing views between researchers and within projects on the problem at hand – e.g. use and impacts of technologies versus social contexts and implications. Moreover privacy is deemed a topic that covers a broad range of technical, social, psychological, cultural and political issues, causing much debate on what privacy, data protection, security, trust and more actually mean.

Ball, K. & Haggerty, K. (2005). Editorial: Doing Surveillance Studies. *Surveillance & Society*, 3(2/3), 129-138.

In a *Surveillance & Society* editorial, Kirstie Ball and Kevin Haggerty provide a reflexive analysis of surveillance studies. They focus on who conducts surveillance studies, for which reasons and in what manner. Emphasis is laid on the multiple disciplinary character of surveillance studies and the need to learn the language of other disciplines. The normativity present in surveillance studies is acknowledged. Ball and Haggerty (2005, 131) point out that surveillance researchers are agents, subject and analysts of surveillance practices, often “motivated by issues of equity, fairness, justice and respect for the person in a digitally mediated world”. Further they critically assess surveillance studies, drawing attention to its unintended consequences. One example is the decrease of security through exposure of surveillance research. In this context they call for a discussion on the ethics of maintaining secrets. Reflexivity is highly pertinent when conducting multiple disciplinary research.

D.2 Summary

As detailed in the survey analysis (Annex C), the contractors gathered knowledge on experiences made in the context of European ICT research in the framework of the FP7. The empirical focus was on projects relating to privacy. The main objective was to analyze the interactions between different disciplinary approaches. After an initial mapping exercise which identified projects, participants and their disciplines, all project coordinators were invited to participate in an online survey. The survey analysis is provided in a separate annex to this report. Five of the thirteen survey responses originated from our list of FP7 and CIP projects that consider 'privacy' or 'data protection' as a theme/topic — ABC4Trust, CUMULUS, EEXCESS, EINS and LINKED2SAFETY. These five projects were subject to a complementary analysis.

Section D.2 provides a summary of the case results. Section D.3 elaborates on the project analyses.

Multiple disciplinarity was difficult to detect in the project deliverables. Often there was no more than a passing reference to multiple disciplinary interactions in the project. In our interviews and April workshop, we received recommendations to investigate the presence of multiple disciplinarity in project publications. This permitted us to gather knowledge on how — and to a certain extent why — project participants worked in a multiple disciplinary fashion in their project outputs. The purpose was to provide insight into the quantity and nature of multiple disciplinary interactions, not to evaluate their merit or quality.

The analyzed projects show varying degrees and types of multiple disciplinarity. The multiple disciplinary interactions do not only or necessarily take place between computer sciences, social sciences and humanities, but between computer sciences, mathematics and medical sciences as well. The analysis confirms that **certain project partners play a key role in bridging disciplinary activities**. This is the case for the Unabhängiges Landeszentrum für Datenschutz Schleswig-Holstein in ABC4Trust and the German National Library of Economics in EEXCESS. Moreover, **prior working relationships and structures enable multiple disciplinarity within projects**. In EINS, Ian Brown and Chris Marsden have professional and multiple disciplinary research experience. Their joint publications marry computer science with law. Further the Nexa Center for Internet & Society in Turin was established with multiple disciplinarity in mind. The EINS project also illustrates that **limited resources inhibit multiple disciplinarity**. Finally, it is clear that **conferences can provide opportunity for interaction and fertilization between research partners and disciplines**. In LINKED2SAFETY, partners at the Institute for Legal Informatics, Leibniz University Hannover participated in a bioinformatics and bioengineering conference, for instance.

D.3 Case data set

D.3.1 ABC4TRUST

Analysis

The coordinator of ABC4Trust Kia Rannenbergh responded to the survey. He indicates that “a trial trying the artifacts developed in the project has as the useful side effect that people of different disciplines have a common goal.” The coordinator has more than 20 years of professional experience and has had more than 4 years of experience in more than one discipline: computer science and economics. Moreover the analysis of ABC4Trust reveals that the partners at the Unabhängiges Landeszentrum für Datenschutz Schleswig-Holstein (ULD) work in a multiple disciplinary manner: computer science and law. Based on publications, Marit Hansen might be identified as a bridge scientist. In ABC4Trust there is crossover between computer science, law and economics.

Project details

Title	Attribute-Based Credentials for Trust
Keywords	Trustworthy ICT
Coordinator country	Germany
Coordinator institute	Johann Wolfgang Goethe Universität Frankfurt am Main
Type of institute	University
Coordinator discipline (proxy)	Mobile business: computer science, economics
Number of partners	11
Countries of partners	France, Greece, Switzerland, Germany, France, Germany, Denmark, Sweden, Sweden, Denmark, Germany
Type of institutes	P (company), RI (research institute), RI, RI, RI, U (university), P, P, Gov (government), RI, P
Discipline of partners (proxy)	Information and communication technology applications <ul style="list-style-type: none">• Information, media: cryptographic software• ICT• ICT, mathematics, storage technologies• Law, privacy legislation• R&D ICT• Computer science, dependable and secure systems and software• ICT• ICT: online security identification

- Government: Swedish city commune
- ICT
- Mobile broadband

Budget EUR 8 849 998

Duration 48 months

Multiple disciplinarity in project publications

- *Computer technology, computer engineering & informatics, business administration*
V. Liagkou et al., "Privacy preserving course evaluations in Greek higher education institutes: an e-Participation case study with the empowerment of Attribute Based Credentials," in Proceedings of Annual Privacy Forum 2012, Berlin: Springer, 2013.
- *Computer science, law and technology, information systems and information economics, security in IT, privacy law and policy*
S. Fischer-Hübner et al., "Online Privacy: Towards Informational Self-Determination on the Internet," Digital Enlightenment Yearbook - The Value of Personal Data, IOS Press, 2013, pp. 123-138.
- *Informatics (in IT security and law publication)*
M. Hansen, "Datenschutz im Web 2.0 – ein Auslaufmodell?," Symposium zu "Sicherheitstechnische und sicherheitsrechtliche Herausforderungen des Web 2.0", Passau Germany, 2011, pp. 23-26
- *Informatics (in multiple disciplinary data protection publication)*
M. Hansen, "Überwachungstechnologien," in Datenschutz – Grundlagen, Entwicklungen und Kontroversen, J. Schmidt, T. Weichert, Eds. Bonn: Bundeszentrale für politische Bildung, 2012, pp. 78-87.
- *Computer science, information systems and information economics*
J. Luna et al., "Privacy-by-Design Based on Quantitative Threat Modeling," in Proceedings of IEEE International Conference on Risks and Security of Internet and Systems 2012, Cork Ireland, 2012.
- *Informatics (in multiple disciplinary data protection publication)*
M. Hansen, "Vertraulichkeit und Integrität von Daten und IT-Systemen im Cloud-Zeitalter," in Datenschutz und Datensicherheit - DuD, Vol. 36, pp. 407-412, July 2012.
- *Informatics (in multiple disciplinary data protection publication)*
M. Hansen, C. Thiel, "Cyber-Physical System und Privatsphärenschutz - Bedarf für eine Analyse von Technikfolgen," in Datenschutz und Datensicherheit - DuD, Vol. 36, pp. 26-30, 2012.
- *Informatics (in multiple disciplinary data protection publication)*
M. Hansen, "Top 10 Mistakes in System Design from a Privacy Perspective and Privacy Protection Goals," in Privacy and Identity Management for Life, Jan Camenisch et al. Eds. Heidelberg: Springer, 2012, pp. 14-31.
- *Informatics (in multiple disciplinary data protection publication)*
U. König, M. Hansen, "Extending Comparison Shopping Sites by Privacy Information

on Retailers,” in Privacy and Identity Management for Life, Jan Camenisch et al. Eds. Heidelberg: Springer, 2012, pp. 171.186.

- *Law, political science and economics, informatics*
L. Holtz et al., “Towards Displaying Privacy Information with Icons,” in Proceedings of the 6th IFIP WG 9.2, 9.6/11.4, 11.6, 11.7/PrimeLife International Summer School, Helsingborg Sweden, 2010, pp. 338-348

D.3.2 CUMULUS

Analysis

The coordinator of CUMULUS Bartolomeo Sapio responded to the survey. He indicates that there was no input from social sciences and/or humanities disciplines into the execution of the research project. Indeed we did not identify an SSH partner in our analysis of the project. There are few multiple disciplinary publications. In CUMULUS there is only crossover between computer science and mathematics.

Project details

Title	Certification Infrastructure for Multi-Layer Cloud Services
Keywords	Trustworthy ICT
Coordinator country	Italy
Coordinator institute	Fondazione Ugo Bordon
Type of institute	Research institute
Coordinator discipline (proxy)	Computer science
Number of partners	7
Countries of partners	Spain, UK, Italy, Germany, Spain, Spain, UK
Type of institutes	P, Uni, Uni, P, Uni, P, P
Discipline of partners (proxy)	Information and communication technology applications <ul style="list-style-type: none"> • Computer science: R&D, wireless sensor networks management, open source software • Informatics, software engineering, cyber security • ICT: software architecture • Engineering electronics • Computer science: security • Consulting: managed services, system integration, IT Systems • Computer science: cloud computing

EU contribution	EUR 2 936 126
Duration	36 months

Multiple disciplinarity in project publications

- *Computer science, mathematics*
C.A. Ardagna, M. Conti, M. Leone, J. Stefa.
Preserving Smartphone Users' Anonymity in Cloudy Days.
Proc. of the Third International Workshop on Privacy, Security and Trust in Mobile and Wireless Systems (MobiPST 2013), Nassau, Bahamas, August, 2013.

D.3.3 EEXCESS

Analysis

The coordinator of EEXCESS responded to the survey. This survey respondent indicates that there was no input from social sciences and/or humanities disciplines into the execution of the research project. The coordinator has between 5 and 9 years of professional experience and does not have more than 4 years of experience in more than one discipline. The analysis of EEXCESS publications confirms that little multiple disciplinarity between computer science and SSH has taken place so far. At the same time, partners at the German National Library of Economics (ZDW) are part of the innovative information systems and publishing technologies unit. The objective of the project is to make European cultural resources accessible through ICT. The German National Library of Economics seems to facilitate fertilization of informatics and semantic web research into the library and museum context.

Project details

Title	Enhancing Europe's eXchange in Cultural Educational and Scientific reSources
Keywords	ICT for access to cultural resources
Coordinator country	Austria
Coordinator institute	Joanneum Research Forschungsgesellschaft MBH
Type of institute	Research institute
Coordinator discipline (proxy)	Technology development: IT, mathematics
Number of partners	9
Countries of partners	UK, Austria, UK, Germany, Switzerland, Germany, Austria, Germany, France
Type of institutes	P, P, Charity, Gov, Cultural Organization, U, RI, P, U
Discipline of partners (proxy)	Information and communication technology applications, social aspects <ul style="list-style-type: none"> • Computer science: software development • R&D

- Documentation, management of information
- Library: economics
- Digital archive management
- Communication science and computer science
- E-learning
- Development and distribution: educational media
- Engineering

EU contribution	EUR 5 349 855
Duration	42 months

Multiple disciplinarity in project publications

- *Innovative information systems and publishing technologies (at German National Library of Economics)*

Timo Borst: [EEXCESS – Bringing the long tail of cultural and scientific resources to the masses](#). Lightning Talk at SWIB13 – Semantic Web in Libraries Conference, Hamburg, Germany, November 2013.

- *Intelligent information systems (at museum conference)*

Silvia Russegger: [Enhancing Europe://eexcess.eu/wp-content/uploads/2013/10/2013.10.15reSources](#). Slides presented at a Conference of the German Museums Association (Herbsttagung des Deutschen Museumsbunds), Berlin, Germany, October 2013.

D.3.4 EINS

Analysis

The objective of EINS is to develop a network of excellence in Internet science. This dictates multiple disciplinarity at the core. The project comprises of 33 partners. Survey and interview respondents indicate that many partners participate on a small budget and that there is a “need for an inter-disciplinary and inspiring coordinator and a flexible PI.” Moreover they reveal that the input from social sciences and/or humanities disciplines into the execution of the research project is “patchy and variable between activities.” The analysis of publications in JRA5: Internet Privacy and Identity reveals that the crossover between disciplines: computer science, law and economics, seems due to prior working relationships and structures rather than EINS itself. Ian Brown and Chris Marsden have professional and multiple disciplinary research experience. Their joint publications marry computer science with law. Further the Nexa Center for Internet & Society in Turin was set up with multiple disciplinarity in mind. In 2013, EINS organized the first international conference on Internet science. Although the relevant publications in JRA5 do not indicate crossover between computer science and SSH, the conference did provide opportunity for interaction and fertilization between research partners and disciplines.

Title	Network of Excellence in Internet Science
Keywords	Future Internet research and experimentation (FIRE a,d)
Coordinator country	Greece
Coordinator institute	Center for Research and Technology Hellas
Type of institute	Research institute
Coordinator discipline (proxy)	Physics, chemistry, biomedical engineering
Number of partners	32
Countries of partners	Belgium, Italy, Austria, UK, Greece, Italy, Greece, Switzerland, Switzerland, Spain, Belgium, Spain, China, Switzerland, South Korea, UK, Sweden, Germany, Greece, Australia, UK, Italy, Netherlands, Italy, Greece, France, France, Sweden, France, Germany, Netherlands, Spain, Germany, France, France, Norway, Netherlands, UK, Greece, UK, UK, Slovenia, UK, UK, UK, Canada
Type of institutes	P, Uni, RI, Uni, RI, Gov, Uni, Uni, Uni, RI, P, RI, Uni, Network (Uni, Civil Society, Gov), Uni, Uni, Uni, RI, Uni, RI, Uni, P, Uni, P, Uni, Uni, P, Uni, P, Uni, Uni Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni, Uni
Discipline of partners (proxy)	<ul style="list-style-type: none"> • Telecommunications • Networking technologies • Technology research, foresight and policy developments • Computer science • Wireless implementation • Internet architectures and protocols • Informatics • Computer science • Communication systems • R&D • Telecoms and software, ICT, markets and policy • Internet architecture and economics • Computer science • Network: social and environmental urban movements • Natural science, life science and bioengineering, engineering, information science and engineering, business, and cultural science • Economics and political science

- Digitization - sociology and law
- Human development and education: psychology, education, sociology and medicine, as well as history, economics, computer science and mathematics
- Informatics and telecommunications
- Technology testbeds
- Social sciences
- Technology, law and economics
- Humanities
- Online trade
- Political science
- Political science
- ICT assessment and market research
- Mobile life: computer science, interaction design, sociology, psychology, but also game designers, artists, dancers, and fashion experts
- Content production and distribution
- Engineering and science
- Electrical engineering, mathematics and computer science
- Computing and networking; computer networks
- Distribution information fusion and environmental economy
- Computer science
- Computer law
- Internet culture
- Computer science
- Psychology
- University: ?
- Computing and communications
- Engineering and IT
- Computer science, electronics, electrical engineering
- Arts, science and social sciences
- Arts, medicine, science and social sciences
- Computer science and electrical/computer engineering

EU contribution
Duration

EUR 4 997 000
42 months

Multiple disciplinarity in project publications (JRA5, Internet Privacy and Identity)

- *Industrial engineering (at multiple disciplinary Nexa center)*
R. Lemma, [“Open Government Data: A Focus on Key Economic and Organizational Drivers”](#). 2013
- *Computer science, law*
I. Brown and Marsden, C., [Regulating Code](#). MIT Press, 2013.
- *Computer science, law (at multiple disciplinary Internet science conference)*
C. Marsden and Brown, I., “Regulating code: A prosumer law approach to social networking privacy and search market interoperability”, 1st International Conference on Internet Science, 9-11 April. 2013.
- *Computer engineering (at multiple disciplinary Internet science conference)*
A. Satsiou, Koutitas, G., and Tassioulas, L., [“Reputation based Coordination of Prosumers Communities”](#), 1st International Conference on Internet Science, 9-11 April. 2013.
- *Communication science, philosophy (at multiple disciplinary Internet science conference)*
P. Coppens, Heyman, R., and Pierson, J., “Social, Local and Mobile Identity Management: The development of a usercentric open SoLoMo platform”, 1st International Conference on Internet Science, 9-11 April. 2013
- *Communication science, cultural science (at multiple disciplinary Internet science conference)*
L. Mostmans, Bauwens, J., and Pierson, J., [“Youth’s attitudes and behaviours with respect to online privacy: A conceptual exploration”](#), 1st International Conference on Internet Science, 9-11 April. 2013.
- *Intellectual property law, computer engineering, institutions, economics and law (at multiple disciplinary Nexa center)*
M. Ricolfi, Morando, F., Rubiano, C., Hsu, S., Ouma, M., and De Martin, J. Carlos, [Survey of Private Copyright Documentation Systems and Practices](#). Ginevra: World Intellectual Property Organization, 2011, pp. 1–70.

D.3.5 LINKED2SAFETY

Analysis

A partner in LINKED2SAFETY responded to the survey. This survey respondent indicates that there was no input from social sciences and/or humanities disciplines into the execution of the research project. The objective of this project is to develop a next-generation secure linked data medical information space for semantically-interconnecting electronic health records and clinical trials systems, advancing patients’ safety in clinical research. In LINKED2SAFETY there is extensive crossover between computer and medical sciences. Further project publications reveal multiple disciplinarity with law, business administration and e-government research. Partners at the Institute

for Legal Informatics, Leibniz University Hannover participated in a bioinformatics and bioengineering conference, for instance.

Project details

Title	A Next-Generation Secure Linked Data Medical Information Space for Semantically-Interconnecting Electronic Health Records and Clinical Trials Systems Advancing Patients' Safety in Clinical Research
Keywords	Patient guidance services (PGS), safety and healthcare record information reuse
Coordinator country	Luxembourg
Coordinator institute	Intrasoft International SA
Type of institute	Company
Coordinator discipline (proxy)	ICT
Number of partners	10
Countries of partners	Ireland, UK, Germany, Greece, Cyprus, Romania, Greece, Greece, Switzerland, Cyprus
Type of institutes	RI, Uni, Uni, RI, Uni, P, P, RI, RI, RI
Discipline of partners (proxy)	<ul style="list-style-type: none"> • Semantic web infrastructures • Biomedical engineering, bioinformatics • Legal informatics • IT innovation • Computer sciences and biological sciences • IT innovation • Software engineering • Biopharmaceutical consultancy • Psychiatric epidemiology and psychopathology • Neurology and genetics
Budget	EUR 3 099 000
Duration	36 months

Multiple disciplinarity in project publications

- *Computer science and biological sciences*
Hasapis P., Ntalaperas D., Kannas C., Aristodimou A., Alexandrou D., Bouras T., Antoniadis A., Georgousopoulos C., Pattichis C., Constantinou A., "Molecular Clustering via Knowledge Mining from Biomedical Scientific Corpora", 2013 IEEE 13th International Conference on Bioinformatics Bioengineering (BIBE), 2013.
- *Computer science, clinical science, mathematics*
Tian, D., Gledson, A., Antoniadis, A., Aristodimou, A., Ntalaperas, D., Sahay, R., Pan,

- I., Stivaros, S., Nenadic, G., Zeng, X., Keane, J., "A Bayesian Association Rule Mining Algorithm", to be presented at the IEEE International Conference on Systems, Man and Cybernetics, Manchester, UK, 2013.
- *Computer science, business administration, psychiatry, neurology and genetics, biomedical informatics*
Sahay, R., Ntalaperas, D., Kamateri, E., Hasapis, P., Beyan, O. D., Strippoli, M. F., Demetriou, C., Gklarou-Stavropoulou, T., Brochhausen, M., Tarabanis, T., Bouras, T., Tian, D., Aristodimou, A., Antoniadou, A., "An Ontology for Clinical Trial Data Integration", to be presented at the IEEE International Conference on Systems, Man and Cybernetics, Manchester, UK, 2013.
 - *Computer science, law, psychiatry, e-government and e-participation*
A. Antoniadou, C. Georgousopoulos, N. Forgo, A. Aristodimou, F. Tozzi, P. Hasapis, K. Perakis, T. Bouras, D. Alexandrou, E. Kamateri, E. Panopoulou, K. Tarabanis, and C. Pattichis, "Linked2Safety: A secure linked data medical information space for semantically-interconnecting EHRs advancing patients' safety in medical research," in *2012 IEEE 12th International Conference on Bioinformatics Bioengineering (BIBE)*, 2012, pp. 517-522.
 - *Computer science, neurology and genetics, psychiatry*
A. Antoniadou, J. Keane, A. Aristodimou, C. Philipou, A. Constantinou, C. Georgousopoulos, F. Tozzi, K. Kyriacou, A. Hadjisavvas, M. Loizidou, C. Demetriou, and C. Pattichis, "The effects of applying cell-suppression and perturbation to aggregated genetic data," in *2012 IEEE 12th International Conference on Bioinformatics Bioengineering (BIBE)*, 2012, pp. 644-649.
 - *Law (at bioinformatics and bioengineering conference)*
N. Forgo, M. Goralczyk, and C. G. von Rex, "Strengths and weaknesses of the European concept of informed consent: Theoretical issues and practical examples," in *2012 IEEE 12th International Conference on Bioinformatics Bioengineering (BIBE)*, 2012, pp. 638-643.
 - *Law (at bioinformatics and bioengineering conference)*
N. Forgo, M. Goralczyk, and C. G. von Rex, "Security issues in research projects with patient's medical data," in *2012 IEEE 12th International Conference on Bioinformatics Bioengineering (BIBE)*, 2012, pp. 541-546.

Annex E: Interviews

E.1 Summary

Interviewer: Trisha Meyer
Date and location: 20 February/23 May/28 May 2014, Brussels/Skype
Interviewees: Christopher Marsden (University of Sussex), Tracy Ann Kosa (University of Ontario Institute of Technology and Microsoft), Jo Pierson and Laurence Claeys (iMinds-SMIT)

In addition to the literature review, survey, case analysis and focus groups, the contractors executed three expert interviews. The motivation for conducting these interviews was that three of the four interviewees were unable to participate in the focus groups organised in November 2013 and April 2014. The aim of the interviews was to dig deeper into the dynamics and conditions of research collaboration across disciplines. The questions focused mainly on the practical experiences of the interviewees regarding barriers and promoters to multiple disciplinarity in ICT-related research. The interviews provide additional sources, deepening insights collected through the other forms of research conducted in this study.

Section E.1 provides a summary of the interview data. Section E.2 details the interview protocol, used to enable systematic collection of insights. We have sought to represent the views of the interviewees as accurately as possible:

Privacy as a focal point in research: there is a growing awareness of its importance. Privacy is multiple disciplinary at its core.

Benefits of multiple disciplinary research: multiple disciplinarity aids **societal appropriation** of technological developments, and leads to **new and better understandings** of societal and research problems.

Hierarchy between disciplines: **the power of computer science and engineering is due to their weight in ICT projects and the overall approach to problem solving.** 33% other disciplines are necessary for meaningful input and change. However engineering is often regarded as the select upper class in science.

Epistemology: there is a need to understand the **differences between positivist and interpretivist worldviews/quantitative and qualitative research.** Computer scientists and engineers tend to have a positivist worldview – knowledge through capturing, measuring and modelling. Most social scientists adopt an interpretivist worldview –

understanding through inquiring into human experience. This creates barriers to cooperate.

Academic environment: it is “**career suicide**” to be **multiple disciplinary**. Multiple disciplinarity is not valorised academically. Junior researchers are especially at a disadvantage.

Characteristics of computer science / Differences between computer and social sciences: gender, timing, approach to research

- Gender: **computer science is predominantly male. Social science is more evenly split.**
- Timing: **computer science is 25 years old** and as a consequence is less concerned about history/legacy
- Approach to research: **computer science is more succinct and tactical.** There is a clear structure of papers: fact, experiment, analysis and future research. The aim in computer science research is to be neat/tight/clear/concise as possible.
- Approach to research: **computer science accepts that projects might fail.** “With the youth of the discipline comes an absolutely enthusiastic approach to every kind of problem. The approach is ‘join the party’.”
- Approach to research: “there is a **willingness across the computer science discipline to integrate with social sciences** [...] as long as I can speak their language [...] Social science academics seem more married to, well I know my discipline and until you demonstrate that you know my discipline as well as I do, your idea does not have merit to me.”

Challenges in integrating computer and social sciences: **awareness of differences, urgency in integrating disciplines, need for a platonic notion of education, need to consider ethics in privacy research, need to step out of comfort zone**

- Awareness of differences: “[w]e are not going to overcome the differences. The best we can do, the ideal is to recognize the differences.”
- Urgency in integrating disciplines: “[i]f we want to influence, which I think we really need to, if we want to get the human into the machine, we need to start doing that yesterday.”
- Need for a platonic notion of education: “we have not reached the point where interdisciplinarity is a good enough contribution or a recognised contribution. We have reached the point where you have one person from one discipline working in another, and that is recognised and acknowledged as being a good contribution to the field [...] We cannot continue to maintain these silos, at least not at the level that they currently exist. [...] Ultimately the quest for education is about being an educated person and learning to think, regardless of what subject matter you dive into.”
- Need for ethical discussions in privacy research: have we identified the rights problem? Are we solving it in the right way? E.g. will electronic health records solve problems of health care delivery?
- Need to step out of comfort zone: “[w]e are all so embedded in the little box that we are familiar with, that it is very difficult to step outside of it and be completely

ignorant in another space for the purposes of learning it, for the purposes of surviving that discomfort to come to a place where we can all ask better questions.”

- **Social scientists need to learn how to translate their theories and ideas into something that computer scientists can work with**

Multiple disciplinary interactions in projects

- False: when **social sciences are only involved at the beginning and the end**. WP1 syndrome – social scientists write a big report, which everyone approves and promptly ignore. Or field trial stage – social scientists are only involved after the technology has been developed, too late to have an impact.
- True: **multiple disciplinarity during the proposal writing, development of use cases/technical components, prototyping and evaluation stages**

Multiple disciplinary practices within projects: terminology and visualization, boundary objects, boundary persons, time, location, project coordinator

- Terminology and visualization: there is a need to **create common language** and to **deliberately make a translation exercise**. Equally important there is a need to **create boundary objects and visualize**. E.g. scenarios, social requirements, personas, TECH cards, mock-ups
- Bridge scientists/boundary persons: there is a need for **bridge scientists/boundary persons**. Bridge scientists think holistically, are passionate about their problem. They are able to translate between teams and disciplines.
- Time: there is a need for **time to build trust, explain and engage**. Include man months for multiple disciplinary engagement in projects and work packages: this allows for time to understand social/technical work packages. “Dagstuhls” and “unconferences” : time dedicated to understand other disciplines. Aim to further each other’s work.
- Location: **shared workspaces are important for collaboration and communication between project partners**
- Project coordinator: there is a need for **an open-minded project coordinator**

Drafting and evaluation of ICT projects: there is a need to include **social scientists in drafting calls and evaluating projects**. “You cannot count on enlightened engineers.”

E.2 Interview protocol

Interviewer:

Date and location:

Interviewee:

Introduction

"We are inviting you to participate in an online survey to help us understand the interactions between different disciplines in ICT-relevant research. Your input is crucial to help us increase the efficiency of the EU research-funding process and will contribute to the debate on the formulation of interdisciplinary approaches in future work programmes. Through our research and own experience, we have decided to approach you as a key informant for the topic.

The results of this discussion will be used without linking to specific individuals or projects, and we ask you to be honest and open in your answers to the questions: this is not part of the project evaluation process at all. We shall not present to the European Commission in such a way that individual people can be identified unless you agree to this.

A workshop reflecting on your insights and those of a survey we are currently carrying out will take place in April."

Ask if OK to record interview, but only for use in writing up notes: any direct text citations will be checked and only attributed if permission given. Assume that no consent form is required.

Questions / checklist

1. Ask interviewee to explain their background: working experience with the Commission's FPs in ICT or other? Awareness of EU-level policymaking processes? Awareness of ICT in general and research processes in general?

General questions about inter/multi/trans disciplinarity

2. In your opinion is it important to execute research that makes use of different disciplines: why/why not? Is interdisciplinarity more than just a mantra? Can you outline the benefits of interaction between disciplines?
3. Have you come across any barriers in your execution of research that made use of multiple disciplines?

ICT-specific questions

4. Is there a hierarchy amongst disciplines in multidisciplinary research in the ICT field? Is this appropriate and can this be optimised?

5. Are multidisciplinary approaches useful in *all* areas of ICT research? And are Digital Social Sciences and Humanities a useful element of this mixture?

Questions assessing existing practices

6. Is it more effective to try to diminish distance and difference between disciplines, or should we focus on what each discipline can bring independently to a project?
7. What kind of (project) structures facilitate good use of multiple disciplinary interactions?
8. How important are individual researchers in the quest for good use of multiple disciplinary interactions?

Wrap up

Thank the interviewee and explain that a final report will be available in the late spring. Note that we shall be in touch to verify any quotations used in the report prior to submission. Any questions?

Annex F: ICT2013 and focus groups

F.1 Summary

The ICT2013 event, held in Vilnius provided the opportunity for the study team to engage with people who are experienced in participating in EU-funded ICT projects. It also provided an opportunity to hear about the emerging rationale of the H2020 programme.

During the event, the survey was trialled and amendments made to the questions when appropriate. The study team also spent time informally interviewing people to gather insights into their experiences with MDAs.

Certain aspects of the smart approach were investigated during brainstorming sessions, which were held on the fringes of the ICT exhibition. Eight people participated in the brainstorming sessions and helped contribute to the discussions that were written up on flipchart paper. These discussions are provided in the following pages. Furthermore, interviews were carried out with three different project coordinators. In contrast to the April workshop (see Annex G for information), the group discussions held at ICT2013 were dominated by actors predominantly from the 'hard' sciences (or 'technical partners').

Keywords that emerged from the discussions held during the event included: Multidisciplinarity is considered to be positively:

- eye-opening,
- about broadening horizons,
- idea generation,
- useful to understand user-centricity.

And yet also sometimes:

- unrewarding,
- time-wasting,
- unproductive,
- not useful for careers of scientific researchers,
- does not provide input into established research paradigms.

Challenges for MDAs emerged as well, during the discussions. The concerns are:

- linking hard and soft (social and exact) sciences without enforcing prejudices and building hierarchies,
- transferring knowledge from one discipline to another,
- playing a role as coordinator,
- understanding each other's languages, (and finally),
- understanding why MDAs are necessary.

The following subsections of this annex highlight the key issues that were raised during the discussions.

F.2 Discussion on project structures

The structure of projects was considered to be a key element of success, particularly when concerning the added value of MDAs. Discussions revolved around how projects should incorporate different disciplines into their activities, with the phrase '**agile approach**' being raised by more than one participant. In this context, 'agility' refers to the way in which projects can deal with a) external inputs (including changes in technology, (societal or policy) requirements, and b) the necessity to re-iterate certain aspects of the project due to internal discoveries.

Several participants in the group advocated a '**topping and tailing**' of projects, with the idea driving this that projects be given space to identify non-technical drivers and provide scope for non-technical expert input into the project, but with the 'technical' experts being given unharnessed space in which to work during the 'middle' of the project. Obviously, this raises questions of the value of additional input from the non-scientific partners in any project.

As part of the discussion on project structures, we also encountered the topic of the nature of the project. The difference (and the different requirements) for a '**delivery project**' as opposed to a '**networking project**' was raised. Clearly, there is a need to distinguish the different MDAs required for both types of project.

Another discussion point revolved around the **embedding of common interactions**, and how these are integrated into the research projects. Criticism of 'distance communication' (such as teleconferencing) was raised. It was noted that such interactions must be regular, and preferably face to face.

Finally, the team structure is often considered to be the key element in making cross-disciplinary endeavours work. First and foremost, **clear leadership**, willing to engage with different disciplines is a cornerstone of such a project. The project leader must be able to accommodate all different disciplinary contributions, and understand the value in their work.

Project structures that encourage successful interaction

topping & tailing - in Projects themselves?

expert input
prior to project?

driver is
non-technical

Agile approach
↳ various iterations
external inputs.
nearly always up!!

Notes: community
building?

common interactions
regular, teleconference
(misinterpretation).

selection
of team

- a) unique
- b) depends on
from deliverables
- c) leadership

Delivery projects vs. network projects

F.3 Discussion on project execution

Concerning project execution, the discussions focused on the hierarchies and broader relationships between different disciplines. These were divided into two major areas: relationships that **enable** more interesting and useful outcomes, and those that **hinder** progression through a project.

Contrary to what we might consider the predominant discourse (and that referred to in our literature review, to some extent), the group felt that there was **no need to spend time trying to understand each others' terminology**, but that projects needed **effective translators** rather than trying to make all individuals open to understanding each other.

It was again noted that the **coordinator (project leader) is the central actor** in ensuring that different disciplines are maximized. The coordinator should **explicitly map out the role of different disciplinary actors** (teams, individuals, units) in the project execution to ensure that the benefits of this interaction are brought forth and contribute to the project's goals. In this way, good coordination would mean that individuals in the research consortium do not feel overburdened but are made aware of the project's priorities and can adjust to those.

An additional point raised discussed how, in such EU-funded projects, individuals from different research units are capable of making a big difference in the execution of projects. **Researchers must be willing to support the project as a whole**, and not only their unit's role within the research project.

Relationships between disciplines

Enabling project outcomes Hindering

no common language necessary!

All depends on coordinator

translators!

interaction is necessary for common (societal) goals.

individuals NOT teams

(open source)

delivery/experimentation

EU projects help instits. redefine internal organisation

explicit mapping of role in projects. → not overburdening, prioritising.

F.4 Discussion on project evaluation

Finally, one of the more heated discussions covered the way in which evaluation takes place. This was initially based on a discussion around two areas of the research project: **proposal evaluation and project review**.

A suggestion was made to **incorporate evaluation into the project structure** itself. This may encourage projects to be more realistic and pragmatic. It will also enable projects to realize that failure to achieve the specific goals set out in the proposal may not be a bad thing. This will also make apparent that **knowledge capture (and thus one of the real benefits of multiple disciplinary approaches) is continuous**, and yet needs to be recorded by someone, in some way.

Criticism was drawn of existing schemes that appear to valorize the technology deliverable over the overall outcome of the research projects; this leads to a more risk-averse approach to project execution and design.

It was posited by more than one member of the discussion that Peer Review as it is currently established in the EU FPs is a “waste of time”, especially since it appears that evaluation and review is “stacked against MDAs”.

Project evaluation and multiple disciplines

specificity of disciplines

evaluation as part of the project
itself

- realistic, pragmatism

- Failure is not a bad thing !!

polymath (bridge scientist,
-translator)

↖ industrial(?)

Outcome not technology
Supply vs demand.

Advisory boards.

→ PO/Peer review: "waste of time".

Proposal evaluation stage
→ eval. stacked against multidiscipline
eval against proposal is ...
knowledge capture = continuous.
(partner?)

Annex G: April workshop and policy forum

Date:	24-25 April 2014
Location:	Institute for European Studies, Vrije Universiteit Brussel
Experts:	Nicole Dewandre (European Commission, DG CONNECT), Peter Burgess (Peace Research Institute Oslo and Institute for European Studies), Jonathan Cave (University of Warwick and RAND Europe), Christopher Marsden (University of Sussex), Wim Vanobberghen (iMinds-SMIT)
Contractors:	Jamal Shahin, Trisha Meyer, Katja Biedenkopf, Dariusz Kloza (Institute for European Studies)

The contractors gathered a select number of experts in a workshop setting to gather additional views on multiple disciplinarity in European ICT research projects. Through focus group and brainstorm exercises, the aim was to engage in a frank and open discussion on the project's four objectives:

1. Identification of the situations where multiple disciplinarity brings added value to DAE relevant policies in the Horizon 2020 programme.
2. Identification of the conditions needed to allow for successful multiple disciplinarity in public-funded research relating to specific policy objectives (at the European level).
3. Analysis of the dynamics among the scientific disciplines in policy-driven ICT research.
4. Focus on the framing dynamics of a multiple disciplinary endeavour which enables maximisation of the value of different disciplines in a research project, specifically noting the role that Digital Social Sciences and Humanities can contribute towards achieving this aim.

The workshop ended with a policy forum open to the public, proposing an initial set of guidelines for research projects with multiple disciplines. What follows is a summary of key discussion points arising from the workshop and policy forum. We have sought to represent the views of the focus group participants as accurately as possible:

Multiple disciplinary incentives for technologists/engineers

1. Negative case: coercion
2. Alibi (e.g. social scientists in projects do the legal/ethical stuff)
3. Positive case: improve the system (e.g. risk management, economics or design)
4. Genuine interest

Enable transfer of technology into multiple contexts (broader scope rather than only particular use): social scientists help adapt to context, show future challenges

Engage endusers from the beginning: long process, but chances for spinoff are much greater, as demand is present from start

Multiple disciplinary incentives for social scientists

1. Clearer understanding: understand technology, which is often a black box
2. Out-of-the-box thinking: expands viewpoints, enriches writing and discipline
3. Confront/confirm truths within own discipline: multiple disciplinarity exposes you to your own terminologies

Difficulty: learn to write in different paradigm to fit project/other disciplines, *but* difficult to submit to own discipline journals/cannot talk to own discipline

Disciplines as toolkits. **They carve out part of the problem. We ask questions that are relevant within our discipline.**

Division should not be technological/social. Technologists have social aspirations of what they want to achieve. Aspiration is already there, perhaps social scientists can help to grasp the complexity e.g. why/how user groups perhaps won't causally change behavior.

H2020 is the very end of chain of where we would want interdisciplinarity. It is the wrong end to start, a hard place to get it going. The right end to start is education and training. H2020 is broken because of all the programmes, personnel development and projects leading up to it.

Bridge scientists **move from their own discipline to another, are able to build connections, are established and can take those risks. They bring their discipline to the problematique of another discipline. They are chameleons.**

Researchers can adapt, but it is difficult: seemingly disparate publications, difficult to step back into hardcore academic career. Difficulty of gap: junior faculty and professors still operate within a single disciplinary gap. It can be career suicide to co-author with several different disciplines.

Shaping a smart approach for multiple disciplinarity

- **Operational timing.** Some disciplines need more time. We need ways of getting beyond time dimension.

GANTT with different time scales: why stability and conformity? Sometimes technologists are fast, while social scientists are slower. Other times it is opposite.

Make social sciences as cross WP: have impact assessments (e.g. economic, privacy) at the beginning, middle and end of projects

Slow science movement: horizontal instruments with funding for institutions, not projects (e.g. CSA). This would be a slower, reflective, non-project based approach.

- **Unconferences/Dagstuhl.** Organize an extensive kick-off meeting. Bring everyone

together at the beginning to create understanding, or at least to have a common sense of misunderstanding (not focused on deliverables and work plan)

Explaining your perspective is essential and builds trust: don't take subtle differences for granted (e.g. affordances, capability, capacity). The same words don't always have the same meaning.

Step out of your discipline: force reading and presentation of paper of another discipline

Need to exchange knowledge, need resources for deep dive

- **Training.** Train social scientists to engage with technologists early on. Training is not just for future scientists but also for participants of projects themselves. Lifelong learning is important.

1. *Apprenticeship.* People to shadow a senior social scientist.
2. *Co-authorship across disciplines.* Publishing is a disciplinary thing. In some disciplines authors are added to publications without having been involved very much.
3. *Co-creation.* Deliverables from projects might need to have a monograph structure rather than different deliverables. Not every discipline writing their different parts of text but co-creating a report/book which different people jointly wrote.

- **Other**

Co-leadership of social scientists. Not just managerial but also substantial. Perhaps also corporate SSH participation: disciplinary mix within partners, not just between partners

Mobility. Joint appointments and sharing a workspace for a while. This allows for intensive cooperation for short periods. Stay at someone's house rather than a hotel,. This brings out different aspects of life.

Challenge the problem-solving approach. This is about framing the problem. The European institutions are too objective-oriented. We need a protocol to start challenging assumptions, not to find solutions.

Annex H: Validation workshop

H.1 Summary

Date:	11-12 September 2014
Location:	European Commission, Albert Borschette Congress Centre
EC:	Prabhat Agarwal (DG Connect), Dirk Beernaert (DG Connect), Nicole Dewandre (DG Connect), Philippe Galiay (DG RTD), Andrea Halmos (DG Connect), Laura Hetel (DG RTD), Mechtilde Rohen (DG Connect), Gérald Santucci (DG Connect), Julia Stamm (DG RTD), Adam Watson-Brown (DG Connect)
Experts:	Stefana Broadbent (NESTA), Patty Kostkova (University College London), Isabella Eiselt (Institut des Hautes Etudes pour la Science et la Technologie – IHEST), Stephanie Rammel (Austrian Research Promotion Agency – FFG), Sean Ryder (National University of Ireland, Galway), Tanja Storsul (University of Oslo), Aidis Stukas (EuroDoc), Jacques Dubucs (French Ministry of Higher Education and Research), Dorit Raines (Universita Ca'Fostari Venice), Geraud Guilloud (H2020 NCP Wallonie), Angela Schindler-Daniels (SSH NCP Germany), Monique Septon (Fund for Scientific Research Wallonie – FNRS), Martin Mueller (Swisscore), Aidis Stukas (Eurodoc), Isabella Eiselt (IHEST)
Contractors:	Dariusz Kloza, Trisha Meyer, Jamal Shahin (Institute for European Studies, Vrije Universiteit Brussel)

The final workshop of this study sought to test the proposed smart approach to multiple disciplinarity. Experts from across Europe gathered to learn from each other, exchange ideas, and improve the final result of this study.

The participants of the workshop expressed **general satisfaction with the smart approach** proposed in the study. A first set of comments for improvements were directed at **crystallization** of points raised, such as the added value of multiple disciplinary approaches, the organisation of sister projects, and the mechanics of multiple disciplinary review and evaluation. Second, during the discussion, it became clear that there is a need to stimulate deep **cultural and institutional change** in order to encourage multiple disciplinarity in ICT research. The importance of the willingness or desire to adopt multiple disciplinary approaches was raised. Many participants recognised that change should occur both top-down and bottom-up, pointing to a shared responsibility among the European Commission and the research community, and encompassing the independent reviewers and evaluators. MDAs were identified as being intrinsically connected with the move towards open

science and innovation. Third, the **dynamics between disciplines** were debated. Participants felt that hierarchies amongst different disciplines in projects is likely unavoidable. As a result, there is a need to explicitly recognize and be aware of the motives and objectives of partners to engage in multiple disciplinarity. Some participants also expressed concern that social sciences and humanities are singled out as agents of MD in call texts, as this emphasises that they are currently undervalued in ICT research. In this context, the European Commission is encouraged to adopt a positive and open approach to disciplinary dynamics, calling for multiple disciplinary approaches that are relevant and appropriate to the project at hand. Finally, participants pointed to **sustainability** in multiple disciplinary approaches. Uncontrolled, importantly also, long-term interaction is deemed important. As one participant aptly phrased: “it takes time to build bridges.”

Section 11.2 on shaping the smart approach elaborates on these particular points in further detail.

The validation workshop consisted of plenary and breakout sessions. The topics of the breakout sessions were determined and led by the participants on the second day of the workshop making use of an Open Space methodology:

1. Shaping the smart approach
2. The role of ‘digital’ in DSSH
3. MD laboratory: physical space for interaction
4. Incentives and reluctance
5. Sister projects
6. From Z to A: better evaluation for better MD approaches
7. ‘Appropriate’ levels of MDA
8. Young researcher involvement

What follows is a summary of the key discussion points raised during these breakout sessions. The summaries aim to portray the richness of discussion held. We have sought to represent the views of the participants as accurately as possible.

H.2 Discussion on shaping the smart approach

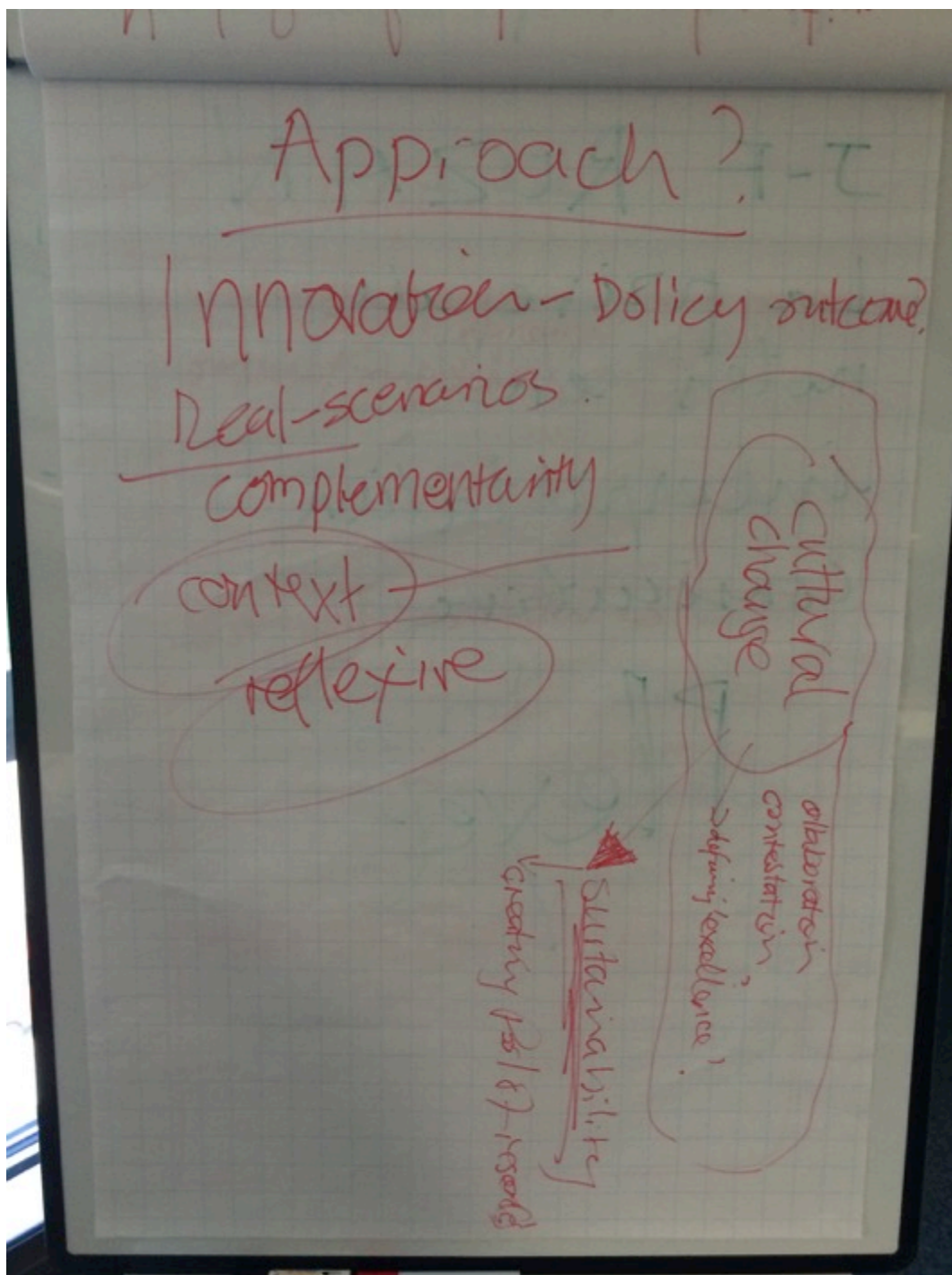
This breakout session was proposed in order to assess the utility of the smart approach itself, to understand how and where there were overlaps, redundancies and missing elements, based upon the discussions that we had held during the past few days. We proposed the need to address certain issues relating to harmonisation and clarity of meaning in the entire approach, both globally, and more specifically in the way in which individual recommendations were written. Essentially, the session was proposed to address the question: “Does the Smart Approach present a coherent and comprehensive way of facilitating multidisciplinary approaches to DAE-relevant H2020 projects?” And “How can this be streamlined or refined to make it clearer?”

Main issues raised

- During the discussions, many participants expressed a **general satisfaction with the structure and contents of the smart approach**, and simply suggested that the study authors revise according to their sentiments emerging from the meeting (these are developed further under the following heading).
- However, there was a larger discussion on the '**cultural change**' aspect of the study, which is implicitly addressed in the study, but discussants felt that this could be brought to the fore more, especially when concerning concrete recommendations.
- It was suggested that a **feasibility phase** for projects could be introduced. In this phase, projects would receive initial funding to test the possibilities for multiple disciplinary interactions. Measures that could be taken into account include (i) the degree of systematic interaction, (ii) the sustainability of interaction, and (iii) the possibility to measure the interaction between partners. Subject to positive review, projects would receive further funding to continue collaboration.
- Further there was a constant underlying discussion on the processes of creativity and innovation in EU funded research. Participants considered that this should be more appropriately described in the smart approach as well; the major outcome being that the study team was invited to emphasise the fact that outputs from projects are not just 'tools' and 'processes' but also 'methods' and 'models.'
- Another concrete recommendation that emerged was to ensure that the study encapsulated the notion of **sustainability in multiple disciplinary approaches** to ICT research; in the sense that activities for researchers who are multiple disciplinary researchers 'in their blood' will be able to find career continuation, and not be subject to project constraints on their working environments.

Consequences for the smart approach

- The main consequence of this discussion for the study team is to add another dimension to their smart approach; that of Aspiration and Attitudes to MD Approaches. This way, the smart approach also encourages researchers to play their role in the exercise. This will highlight an on-going discussion on how to highlight and define 'excellence' in multiple disciplinary environments.
- As a consequence of other discussions during the validation workshop, the study team will also address some other issues in the smart approach, relating to clarity and harmonisation across the different dimensions of the approach.



H.3 Discussion on the role of 'digital' in DSSH

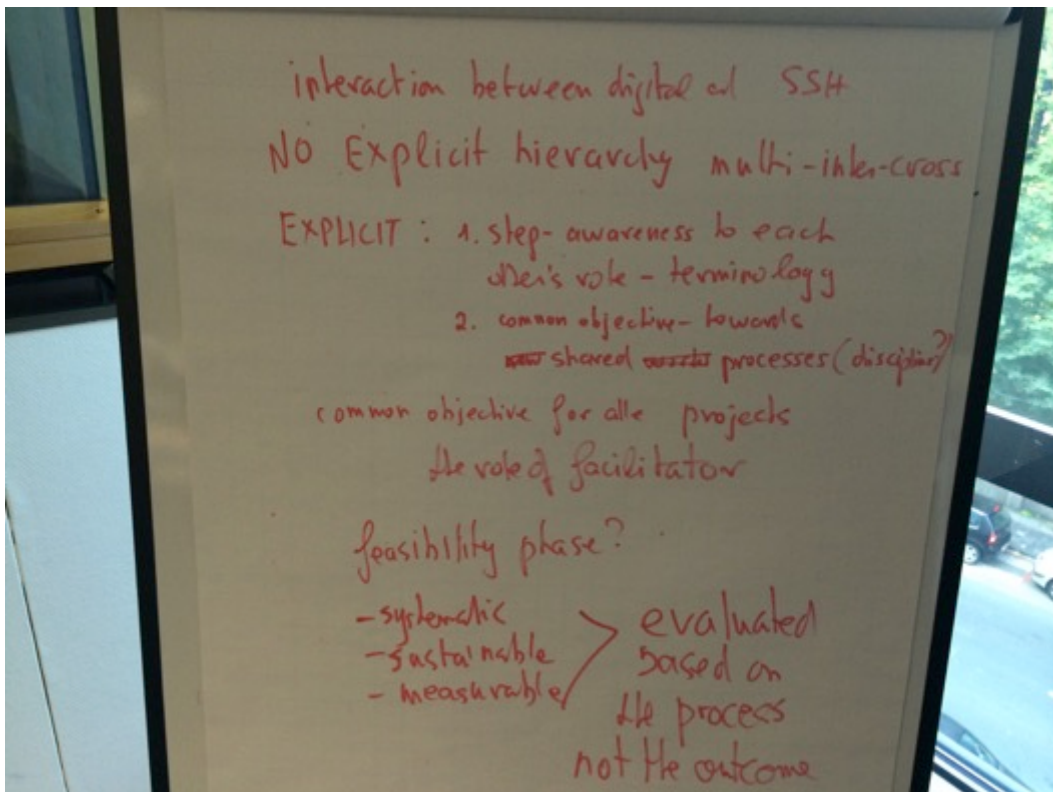
This breakout session focused on the interactions between disciplines in research related to the digital environment.

Main issues raised

- Participants in the session shared that **multiple disciplinary research often occurs without explicit formulation of the objectives** that each disciplinary partner wishes to achieve through the collaboration. This tends to result in situations where partners are involved in multiple disciplinary projects in order to 'use' the other discipline to reach their own objectives.
- Although it was posed that it is not necessary to determine the final objective of multiple disciplinary research from the outset – and therefore it is not necessary to determine whether the research is multi/trans/interdisciplinary in nature, **it is desirable to discuss the role of each disciplinary partner and to work towards flexible common objectives.**
- The role of a multiple disciplinary facilitator was deemed important in explicating roles and objectives. Moreover it could be useful to build in a feasibility phase for projects (for instance one year of pre-funding) in order to evaluate how/whether a multiple disciplinary approach adds value. Finally it was pointed out that researchers tend to **evaluate success of multiple disciplinarity based on process rather than outcome of projects.** One participant boldly stated that the evaluation procedure for European proposals kill multiple disciplinary ideas.

Consequences for the smart approach

- We should emphasize the interactions between disciplines rather than the role of DSSH in ICT research, and the importance of processes underlying multiple disciplinary research.



H.4 Discussion on a multiple disciplinary laboratory: physical space for interaction

This breakout session focused on how to create time and space for multiple disciplinary approaches.

Main issues raised

- Participants in the session shared that **multiple disciplinarity is difficult to achieve in European projects due to a) the short duration of collaboration and b) the physical distance between partners**. Moreover it was emphasized that there is a need to build awareness that multiple disciplinarity extends far beyond the context of European projects.
- Successful multiple disciplinarity can only be achieved if **structures for long-term interaction** within and outside the project context are set into place. Ultimately what is needed is cultural and institutional change placing multiple disciplinarity at the centre rather than at the margins of research.
- Further it was deemed that solutions should not originate in the European Commission only. Project partners – universities and industry alike, and member states have a role to play.
- Participants encouraged the facilitation of **research mobility** within projects, the adoption of **mutual learning plans** in university programmes, the creation of **European Centres of Excellence for Multiple Disciplinarity**, and the allocation of **seed funding for multiple disciplinary projects through COST**, the intergovernmental framework for European Cooperation in Science and Technology.

Consequences for the smart approach

- Structures for long-term multiple disciplinary interaction are necessary to ensure the success of the European Commission's smart approach.
- Cultural and institutional change in favour of multiple disciplinarity requires both bottom-up and top-down initiative.

- Need for long term interaction
- Mobilisation & Mutual Learning Plans
→ SWAFS
- Multidisciplinarity goes beyond projects
⇒ community building
⇒ leading to structural change
- Time needed for 'cultural change'?
- ERA? role of MS
- call to set up new ~~institutions~~ structures within ^{institutes}
European Centres of excellence for NDA
bottom-up?
→ industry and sustainability.
- Need for a call for a culturally change?
institutional
- COST as a seed

H.5 Discussion on incentives and reluctance

This breakout session focused on incentives and barriers to engage in multiple disciplinary research.

Main issues raised

- **Incentives for engaging in multiple disciplinarity:** (open) innovation, publications, continuity in research, composition of the research consortium, and more.
- **Interactions between disciplines: equality?** In what situations can 'inferior' disciplines still be incentivised to join? Only if the work they have to perform is satisfactory for them, lives up to their expectations.
- Participants in the session deemed that partners engage in multiple disciplinary research if it makes a difference for the project or benefits them in other way. Industry partners are interested in putting the product on the market in a fast way. For instance, a company tried to introduce a child nutrition product on African markets. However, water was not clean enough, and the introduction of the child nutrition product resulted in waterborne illnesses. Had anthropologists participated in putting this product on the market, this could have (most probably) been prevented.

Consequences for the smart approach

- Partners engage in multiple disciplinary research if it makes a difference for the project or benefits them in other way.
- Partners bring their own expectations and objectives to projects. A multiple disciplinary project should try to reasonably accommodate them all.
- Some disciplines could be 'inferior' to others. The multiple disciplinary exercise remains valuable when this 'inferior' discipline gets what it wants.

Incentives

objective data

↳ social factors

CS ^{real world} (Problem) ↔ H/Health /...

Reluctance

research ↔

innovation

Evidence-based Public Policy

- innovation

- scientific perspectives

- publication

- hybrid problems

- ambitions

- mentality in Europe

- composition of consortium

^{human factor}
"right people" "WANT" to do it

- communication

- new proposals building on existing successful ones

- culture

- open innovation

- Connection of health
+ social data

- disciplines equal
or not

- benefit for project - quicker to
market (industry)

- making a difference to

"the project" from the
beginning

= real problem

- road to market / ^{real} ^{world} _{solution}

- real world impact

- misconceptions about SSR

- mixing "cultures" - not "adding SSR"

H.6 Discussion on sister projects

This breakout session was proposed in order to get to grips with the concept of sister projects, as introduced in the smart approach. It was agreed that there was a curiosity to understand how such a mechanism would add value to current and planned activities in the H2020 programming, and furthermore, how it would actually be implemented in practice. Questions that launched the discussion concerned how the projects would interact, how they would be called for, and how they would be reviewed and evaluated.

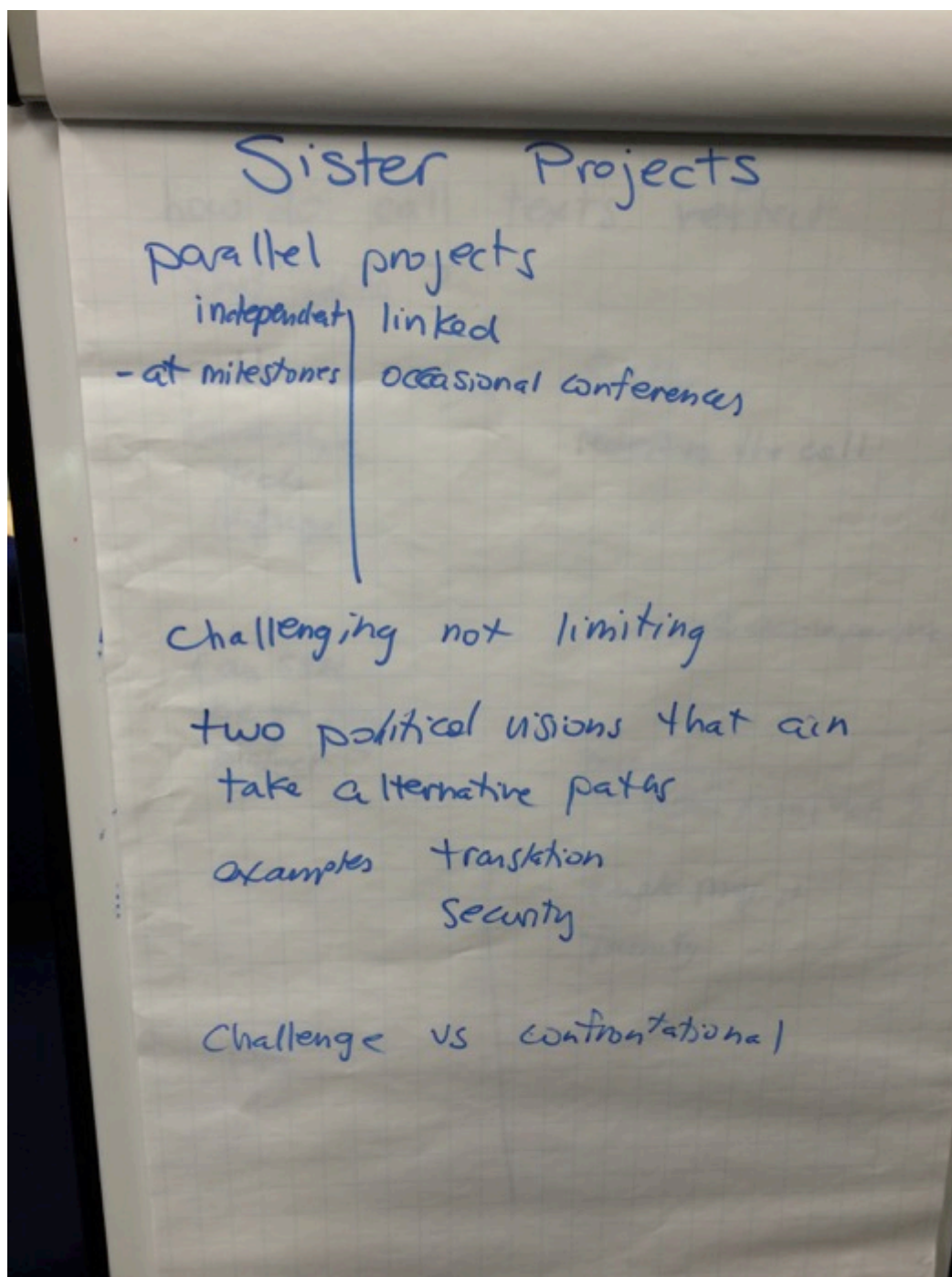
Main issues raised

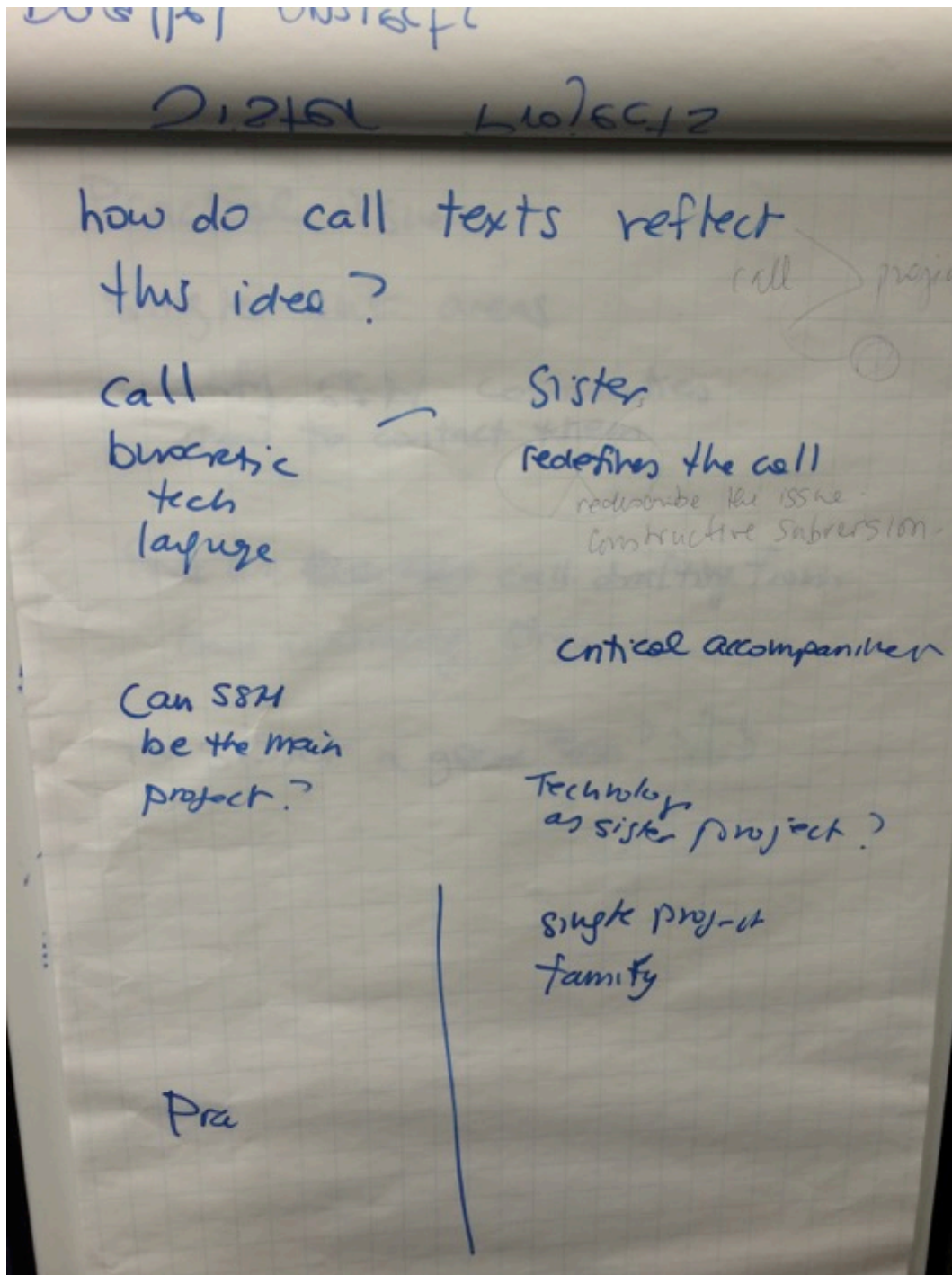
- Sometimes multidisciplinary approaches are best taken outside of specific projects; forced integration is not the most useful or creative approach to deal with a problem.
- Sister projects should not be driven by confrontation (to another specific project) but are more about having a margin of freedom to challenge the orthodoxy, in the sense of ‘constructive subversion.’ They would not simply critique, but examine “what if?” questions that are raised when considering the role of technology in society.
- Often, the critical, more reflexive approach taken by social scientists tends to be subsumed into a solution-driven project, which does not allow for challenges to a single dominant preconceived solution; alternative solutions are often possible, practical, and sometimes far more useful in terms of policy/societal impact: they enable **seeds of conceptual innovation** to bloom.
- Rather than in a CSA or limited to the review process, sister projects increase the **intensity of response** to specific developments in ICT-driven approaches to digital society.
- The introduction of a ‘sister project’ approach will enable the process of ‘**critical accompaniment**’ to technologically-driven projects that tend to put the solution not at the end of the process, but at the beginning.
- These projects should run independently, and their interaction should be structured in such a way that the dominant approach concerns **challenging and not confronting** (no binary logic of wrong/right is necessary).
- A ‘sister project’ should be free to **examine and critique**, working on more interpretivist (less positivist) principles.
- Sister project instruments **free up the constraints imposed on call text authors** to ensure user/social issues are embedded into all projects
- Sister projects provide ONE solution that is applicable in some key areas, notably: Robotics, Internet of Things, Big Data, Language and Security.

Consequences for the smart approach

- We concluded that sister projects can be easily instrumentalised in the current H2020 system. One sentence can be added to most call texts requesting, e.g. that “proposals are also welcome on topics that critically address the topic described here.”
- The evaluation process for such projects must be different to other projects, with maybe a more ERC-type review process put in place for them.

- We recommended that sister projects are introduced as one of the key characteristics of the smart approach into key elements of the work programme, where there is capacity to launch several projects on a theme, where contestation is apparent on the themes in a specific topic area, and where there is a potential for critically challenging the topic description in the call text.





ask 1.450
nom 90 call text 2 1st/1st.

Practical issues

Single out areas

identify SST/ communities
how to contact them

Free us ~~from~~ the call drafting from
bad working stress

is sister a good term? YES

2020 to 2022

12/21/2020

*Robotics

(Smart Cities)

*Language
(e health)
(e gov)

*IoT

*Big Data

*Security

* Foundations

* 2012

* 5000000

(2nd cycle)

Evaluation | Impact

Channels back to policy

↓
Reframing work programmes
and
policies

H.7 Discussion on from Z to A: better evaluation for better multiple disciplinary approaches

This breakout session focused on learning from the past in order to improve future multiple disciplinary approaches.

Main issues raised

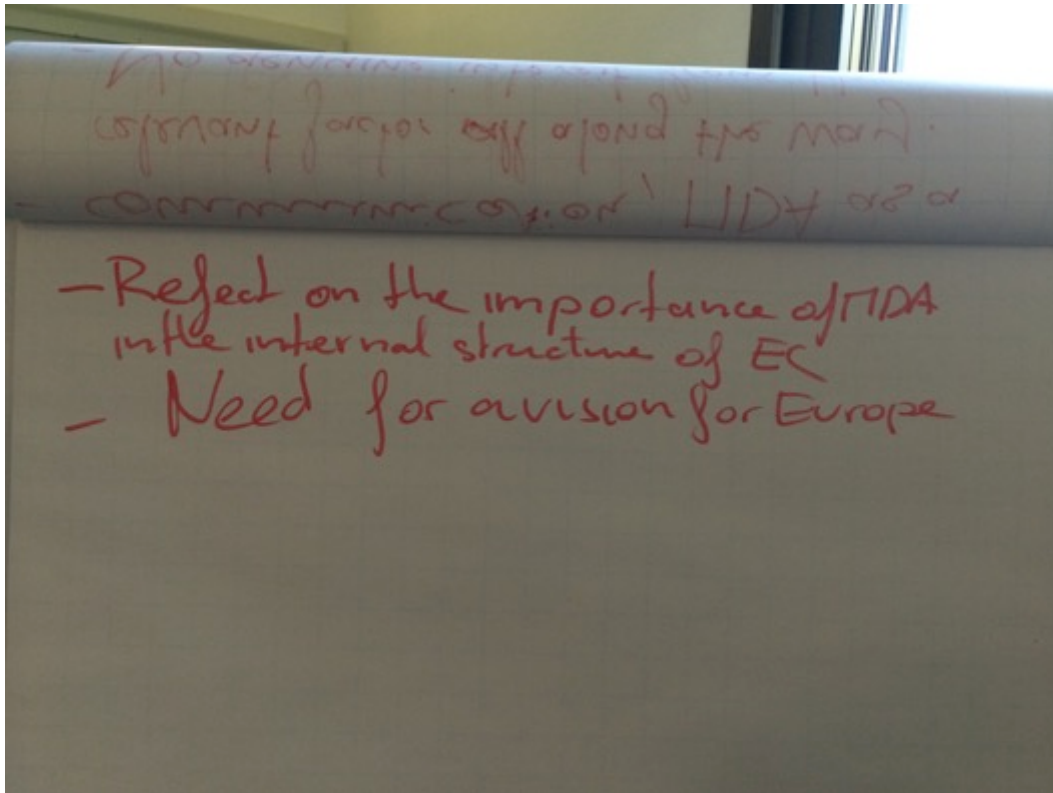
- Participants in the session shared that it would be useful to conduct an **analysis of retained and rejected research proposals** that emphasized multiple disciplinarity. This would permit **showcasing successful multiple disciplinarity and allow to analyse why others failed**.
- It was recommended to develop a '**MDA toolbox**' for evaluators, applicants, Commission staff and the research community.
- Further it was deemed important that current MD discourse stresses the embedding of social sciences and humanities (SSH) in technology research. However multiple disciplinarity is broader – it equally comprises collaboration within SSH and technology research. The terminology regarding 'embedding SSH' conveys a wrong signal.
- In this context the role of communication more broadly was raised. Participants considered that there is a need for **an EU vision paper and a standing committee on MDA (or 'The Human Agenda', inspired by the 'Digital Agenda')** to communicate the relevance of multiple disciplinarity, including SSH for the European Commission, but also to policy-makers in general. There was some doubt whether interest in multiple disciplinarity is shared across the European Commission. It was recommended to reflect multiple disciplinarity more clearly in the institution's organogram.

Consequences for the smart approach

- Multiple disciplinarity is more than integration between SSH and technology research. It is equally about the collaboration within SSH and technology disciplines.
- Communication and choice of wording is key (e.g. 'embedding SSH' terminology is counterproductive).
- We need to analyse, learn and communicate from past retained and rejected multiple disciplinary approaches.
- MDA should not be imposed everywhere. A quality-based approach has to trump a quantity-based approach.
- An EU vision paper on the 'Human Agenda' could be developed.

! Perception perception qualities of SSH

- Communication, PIDA as a relevant factor all along the way.
- No genuine interest from the services to invest in PIDA
- PIDA toolbox for evaluators, applicants, people in the services and the community.
- Analysis of returned & rejected proposals.
- Strengthen the role of SSH coordinator
- Wording of PIDA context: it is not only about embedding SSH.
- Do not impose PIDA everywhere: Qualifies Quantity.
- Showcasing good PIDA.
- Learn from the past
- Question ~~form~~ of discourse: not only about SSH vs technology.
- Role of observers in consensus meetings
- Need for an EU vision paper & standing committee on PIDA or the Human Agenda (Digital Agenda)



H.8 Discussion on 'appropriate' levels of multiple disciplinarity

This breakout session focused on means to determine the appropriate level of multiple disciplinarity in research.

Main issues raised

- Participants in the session concluded that **it is difficult to decide in advance where multiple disciplinarity is more or less needed**. As the study points out, it might be easier to determine where multiple disciplinarity is not required.
- In line with other workshop sessions, the desire to conduct multiple disciplinary research was emphasized. It was considered **necessary to adopt an open approach to multiple disciplinarity**, e.g. allowing project applicants to suggest where they deem that MDAs add value and which multiple disciplinary processes they would integrate in their project.
- At the same time, participants shared that MDAs should be mentioned in both overall and project level **call texts**. It was not decided whether references should be formulated in a specific or broad manner. Finally, the European Commission is encouraged to include MDAs as a criterion in **proposal evaluations and project reviews**.

Consequences for the smart approach

- The study team should further emphasize the difficulty to determine the appropriate level of multiple disciplinarity prior to project commencement.
- We need to encourage more 'intelligent' references to MDAs in call texts and the inclusion of MDAs as a criterion in proposal reviews and project evaluations.
- Finally if reviews and evaluation can take steps forward with regards to multiple disciplinarity, we need to ensure that research communities and policy stakeholders are well informed. National Contact Points could be one way to achieving this goal.

"Appropriate" Levels of MDA

where is MDA more needed?

for whom / for what?
who decides? how?

How is this related to inspiration desire
Disciplinary Hierarchy?

Impact (factors) - Indicators

Evaluators - Evaluation

bridge-
objects

process-orientation ↔ MDA
vs
outcome-orientation

fostering MDA cultures

pre-phase of projects

effectiveness
of
evaluation

communicate
to applicants how
to secure effectively
of evaluation
in context of MDA

H.9 Discussion on young researcher involvement

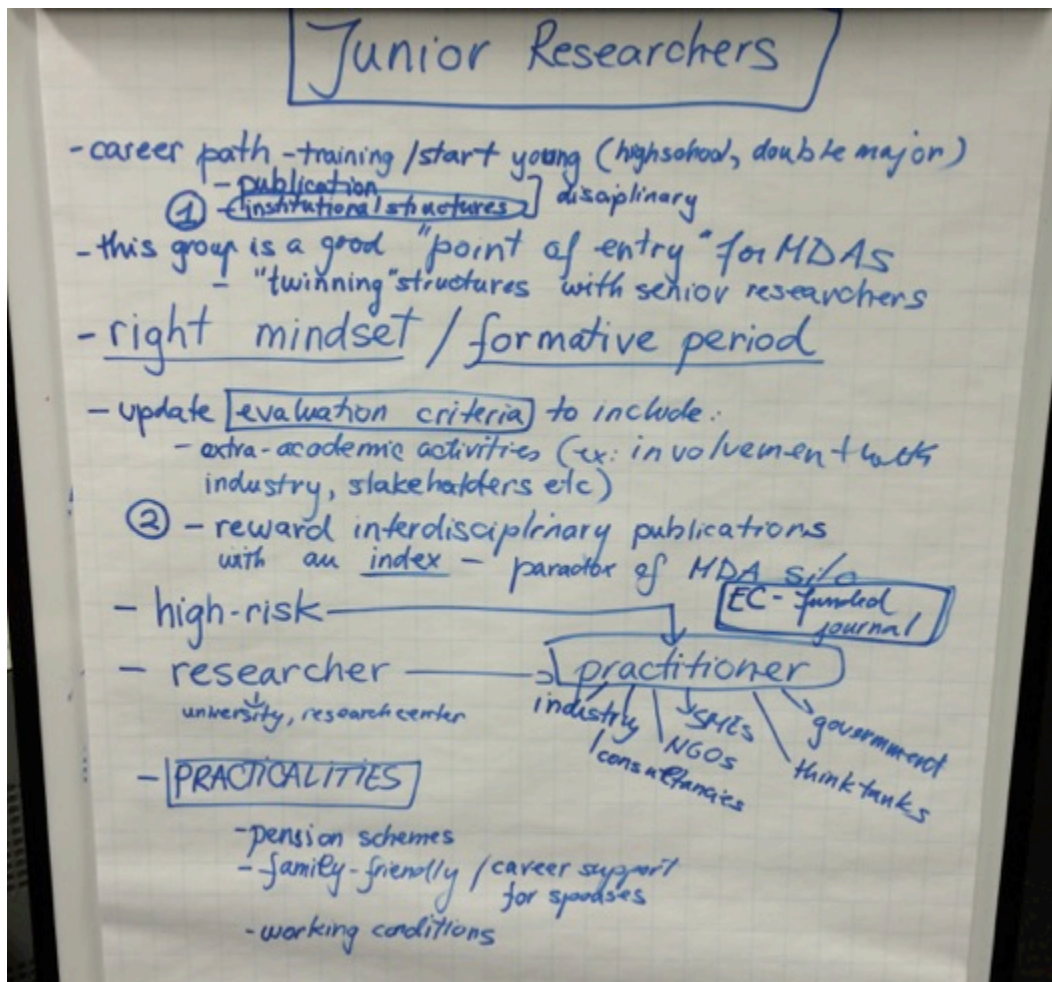
This breakout session focused on the opportunities and challenges for young researchers in multiple disciplinary research.

Main issues raised

- Participants identified **three main problems** that young researchers face while involved in a multiple disciplinary endeavour: (1) **the structure of the institution**, e.g. a university, (2) **the criteria for evaluation**, and (3) **the practical arrangements**.
- Structure of the institution. In the session it was deemed that a university is a 'medieval-style' institution: highly hierarchized, works in silos of single disciplines, within both its educational and research mission. University structures prevent the flourishing of multiple disciplinary activities: single discipline faculties, research groups, degrees, journals, conferences, and more. Young researchers are not well prepared for multiple disciplinarity.
- Participants proposed a variety of solutions related to the structure of institutions: embark on multiple disciplinarity as early as possible, even in the formative period – (a) **multiple disciplinary Master degrees** e.g. European Master in Law & Economics, (b) **student exchanges**, e.g. a requirement that could be introduced in the Erasmus programme is that certain students must enrol at their host institution in a faculty or a research unit working in a different discipline, (c) **staff exchanges**, e.g. in schemes such as Marie Curie Actions where individual researchers travel to another organisation, ensure they would work within a different discipline, (d) the EU could make **long-term funding available for organisations willing to run a multiple disciplinary journal**, and (e) despite the lack of expertise even in a single discipline, **involve young researchers in multiple disciplinary projects**.
- Criteria for evaluation. Evaluation criteria, as of now, stay within single disciplines. However extra-curricular activities could be rewarded, such as establishing a ranking/impact factor for multiple disciplinarity.
- What young researchers can do after obtaining a multiple disciplinary PhD? Participants in the session stressed that academia is not the only solution. Moving to practice, young researchers could work in the public sector, NGOs, think tanks, industry and consultancy. Those might be the places where multiple disciplinarity receives higher rewards. Take for instance the value of law and economics for financial audit business.
- Practical arrangements. Finally participants shared that young researchers embarking in multiple disciplinary projects must usually travel to another institution, located in another country. In this context, several questions were raised: How will their pension schemes be calculated after years of work in different countries? Will their national health insurance remain valid? Are they allowed to take their partner/spouse and children? Will the hosting institution ensure job for their partner/spouse?

Consequences for the smart approach

- Embark in multiple disciplinary activities as early as possible. This would require a change in the organisational structure of a university.
- Due to the lack of 'popular demand' for multiple disciplinary journals, the European Commission could enable funding, in a long term, for organisations willing to launch and run an open access multiple disciplinary journal.
- We could analyse the career paths of multiple disciplinary PhDs willing to work outside academia after graduation.
- We need to ensure that practical problems for young researchers involved in multiple disciplinary activities are solved: pension, insurance, family.



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